The application of a new visualisation producing strategy in landscape planning and design: A case of visualisation in public participation in Kura Tāwhiti | Castle Hill

A Dissertation
submitted in partial fulfilment
of the requirements for the Degree of
Master of Landscape Architecture

at
Lincoln University
by
Xinghua Huang

Lincoln University
2021

THE APPLICATION OF A NEW VISUALISATION PRODUCING STRATEGY IN LANDSCAPE PLANNING AND DESIGN

A CASE OF VISUALISATION IN PUBLIC PARTICIPATION IN KURA TĀWHITI | CASTLE HILL

A Dissertation submitted in partial fulfilment of the requirements for the Degree of Master of Landscape Architecture at Lincoln University

By Aria Huang

Abstract

With the rapid development over the past few decades, visualisation today was not just limited to the conventional still image, such as photomontage. Techniques like video simulation and panoramic video simulation drew more and more attention from scholars as they provide audiences with richer information and better sensory experience about a landscape. However, the use of these techniques remains rare in practices due to a range of reasons, such as lack of data sources and time-consuming production workflow. Some scholars suggest that place the modelled and rendered changed part of the landscape into captured (photographed or filmed) unchanged landscape settings, rather than modelling the whole landscape. This may be able to solve the problems encountered by the current production of video simulations and panoramic video simulations. Therefore, this research aims to experiment with this visualisation strategy and discuss its applicability in a practical background of Kura Tāwhiti Castle Hill, by comparing the effectiveness (i.e., the capacity of producing high-quality visualisation) and efficiency (i.e., the ease of using the techniques) of applying the strategy in producing photomontages, video simulations and panoramic video simulations. This study provides landscape architects with more possibility for landscape visualisation, as well as some evidence for visualisation producers to select visualisation tools.

Keywords: Visualisation, digital landscape visualisation, video simulation, panoramic video, landscape planning and design, landscape architecture, public participation.

Acknowledgements

I would like to thank my supervisor Dr Gillian Lawson for her guidance and energy during this challenging yet rewarding journey. I couldn't have done this without her support and help. I am profoundly grateful.

A thank you to editor Joan Gladwyn who helped me revise the final draft.

Special thanks to my mom, who has been so supportive in my study all along.

Finally, I would like to thank my boyfriend, Hanley, for his ongoing support and help throughout the past year.

Table of Contents

List of Tables

List of Figures

Chapter 1
Introduction

1.1 Background

1.1.1 Public participation in landscape planning and design

Since the 1950s, public participation has always been a part of an evolving continuous discourse of landscape planning processes (Hemmersam, Martin, Westvang, Aspen, & Morrison, 2015). Public participation refers to the practices that have interested or affected public groups engaged in decision-making processes (European Urban Knowledge Network, n.d.; Pacione, 2019; United States Environmental Protection Agency, n.d.; Wouters, Hardie-Boys, & Wilson, 2011).

Public participation is an essential and beneficial process for landscape planning and design practices (International Association for Public Participation, 2006; Wu, He, & Gong, 2010). It is suggested by many scholars that public participation is a way of empowering citizens, as well as a way of improving the quality of decision-making (Pacione, 2019). In most Western countries, public participation in the landscape planning processes is a political goal, as well as what people expect (Warren-Kretzschmar & Tiedtke, 2005). It also provides planners and decision-makers with opportunities to communicate with the public (Wouters et al., 2011). Effective public participation can identify the views of the public and further help planners and decision-makers to make planning decisions more wisely to achieve a planning result that is more sustainable and has more social acceptance (Barlow, 1995; International Association for Public Participation, 2006; Wanarat & Nuanwan, 2013). However, it is often problematic when conducting public participation in practice, even if it is of high importance to landscape planning and design (Holman & Rydin, 2013; Wanarat & Nuanwan, 2013). Many scholars have expressed their concerns about the effectiveness of information communication in public participation practices (Conrad, Cassar, Christie, & Fazey, 2011; Cooke & Kothari, 2001).

For example, one of the important factors in public participation practices is that the people involved in the process are usually not professionals in urban planning or other relevant industry, and their understanding of design interventions varies largely due to their different educational and cultural backgrounds, social experience and so on (Lewis & Sheppard, 2006; Wu et al., 2010). Therefore, in this case, if the designer/planner only verbally describes the scenario of future landscape planning to the public, and the public's understanding of these scenarios is entirely based on their own imagination, then this process is likely to lead to misunderstanding, and the subsequent decision-making results are no longer credible.

1.1.2 Visualisation in support of public participation

It is now widely recognised that it is beneficial to improve the way of communicating information to the public, which can not only attract more participants but also improve the quality of their participation (Beierle & Cayford, 2002).

Today, applying visualisation techniques in landscape planning and design processes has also become more and more popular (Berry & Higgs, 2012; Gill, Lange, Morgan, & Romano, 2013; Lange, 2011; Wu et al., 2010). And the visualisation technique has already become the primary method used by planners for communicating information with the public and stakeholder (Pettit, Cartwright, & Berry, 2006; Warren-Kretzschmar & Von Haaren, 2014).

In the field of landscape architecture, visualisation refers to techniques that explain proposed landscape changes in the form of visual information such as images, animations, and so on (Olsson, 2020). Back in 1988, Canter, Stea, and Krampen (1988) compared the effectiveness of verbal and graphic communication in public participation (as shown in Table 1-1). Compared with verbal/written information, visual information can contain more information from different dimensions at the same time, and the process of communication changes from passive receiving of information to active. It is also widely recognised by other scholars that graphic media are more effective and accessible than traditional written or verbal messages in the communication process (Canter et al., 1988; Orland, Budthimedhee, & Uusitalo, 2001; Steinitz, 2010).

Table 1-1 Comparison of the ways of communicating information in public participation (verbal vs. graphic/spatial) (adapted from Canter, Stea, & Krampen's “New directions in environmental participation”, 1988)

	Verbal	Graphic / Spatial
Development of ideas	Linear	Non-linear
Communication	Primarily monologic, passive	Primarily dialogic, active
Direction of exchange	Public express needs, experts plan	Public and experts plan jointly
Verbal/graphic interface	Translational	Non-translational — direct joint development of spatial/visual proposals
Facilitators’ strategy	Meet with homogeneous groups separately	Bring all groups to a common forum

In the process of public participation in landscape planning and design, landscape designers, as visualisation producers, may play a role as an intermediary between the planning scheme and the public (as shown in Figure1-1). Keravel (2010, p. 70) describe this as "[landscape architects] are catalysts, they trigger off processes; they provoke situations of exchange and dialogue between a place and a public". Visualisation has become a "common currency", which could help to improve the public's understanding of the landscape and spatial issues and minimise miscommunication (Al-Kodmany, 1999; Kempenaar, Westerink, Van Lierop, Brinkhuijsen, & Van den Brink, 2016; Langendorf, 2001; Salter, Campbell, Journeay, & Sheppard, 2009; Warren-Kretzschmar & Von Haaren, 2014). This can also help the public with sharing their knowledge and ideas, and therefore facilitate the whole process (Al-Kodmany, 1999; Kempenaar et al., 2016; Langendorf, 2001; Orland et al., 2001; Salter et al., 2009; Warren-Kretzschmar & Von Haaren, 2014).

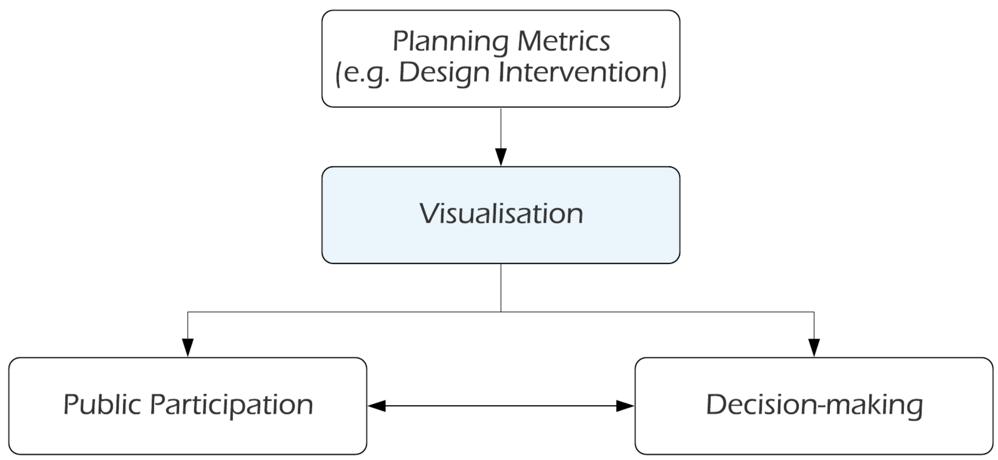

Figure 1-1 Visualisation as a presentation and communication tool for landscape planning and design (adapted from Pettit, Cartwright & Berry, 2006)

However, it must be recognised that the use of visualisation technology does not necessarily contribute to a better result of public participation (Steinitz, 2012). On the contrary, the abuse of visualisation technology may mislead the public, leading to a lack of credibility in the final decision. So the key question is how we should effectively use this technology to give full play to its advantages.

In comparison with using visualisation techniques in other fields, applying visualisation techniques in the landscape architecture and planning field is much more complicated (O. Schroth, Sheppard, Lange, & Schmid, 2008). The visualisation techniques required vary considerably according to the context, audience, evolved landscape elements and so on (Lovett, Appleton, Warren-Kretzschmar, & Von Haaren, 2015; Steinitz, 2012). Also, the landscape elements within a project were often dynamic (e.g., weather and running water) and varied in form (e.g., trees and rocks) (O. Schroth et al., 2008). This makes it even more challenging to apply visualisation techniques. A similar view was also suggested by Foley et al. (1996) – the major difficulties of landscape visualisation come ultimately from the complexity of the real world.

Landscape visualisation is a rapidly growing field. A large variety of visualisation techniques are available for landscape architects today. Video simulation and panoramic visualisation drew more and more attention from scholars as they can provide audiences with richer information about the landscapes to be communicated and more vivid and better sensory experience (Liu, Zhang, & Li, 2016). However, the use of these techniques remains rare in practices due to a range of reasons, such as insufficient visualisation quality (Buhmann, Jähne, & Eckert, 2003; Ervin, 2001; Lange, 2001), lack of data sources (Buhmann et al., 2003; Lange, 2001), and time-consuming production workflow (Tress & Tress, 2003). These issues are all related to the 3D modelling process, on which, video simulation and panoramic visualisation techniques heavily relied.

Bishop and Lange (2005b) questioned the way landscape visualisations are made today in their publication "Visualisation Prospects": "Why should we take the trouble to model those components of the landscape that are not changing? […] Why should we not use imagery of the existing landscape and only use computer graphics to represent the areas of change?" This actually has pointed out a possible future direction of visualisation techniques – place the modelled and rendered changed part of the landscape into captured (photographed or filmed) unchanged landscape settings, rather than modelling the whole landscape (Bishop & Lange, 2005b). This can minimise the problematic 3D modelling process in current workflows of producing video simulation and panoramic visualisation. However, there is little research on such visualisation strategy.

1.1.3 An ongoing study of tourist participation in the planning and design of Kura Tāwhiti | Castle Hill

At present, an ongoing study provides an opportunity and practical background for this study to conduct in-depth research on the practical application of visualisation technology to public participation. This section introduces the ongoing research (Section 1.1.3.1) and the relationship between the ongoing research and this research (Section 1.1.3.2).

1.1.3.1 Introduction to the ongoing study

Kura Tāwhiti Castle Hill is a famous tourist destination on the South Island of New Zealand (Apse, Stewart, & Espiner, 2020; Barnett, 1991; Robinson, 2019). It is beside the State Highway 73 in the Waimakariri Basin in Selwyn District (as shown in Figures 1-2 and 1-3), and is near to Christchurch city, within an hour's drive (Robinson, 2019). State Highway 73, also known as the Great Alpine Highway, connects Christchurch with the West Coast, and passes through many small townships and tourist destinations along the way (Selwyn District Council, 2019). It is one of the most popular touring routes across the South Island (Deviating the Norm, 2015; Larsen, n.d.). For a long time, Kura Tāwhiti has been famous for its distinctive sculptured landforms (as shown in Figure 1-4) and it attracts many tourists (Department of Conservation, n.d.; Robinson, 2019; Walrond, n.d.). Hayward and Boffa (1972) describe the "outstanding" view as "Extensive in length, breadth, scale and content and overpowering in its visual complexity".

Figure 1-2 Kura Tāwhiti Castle Hill is located in Selwyn District, next to State Highway 73 (also called the Great Alpine Highway), which connects Christchurch with the West Coast

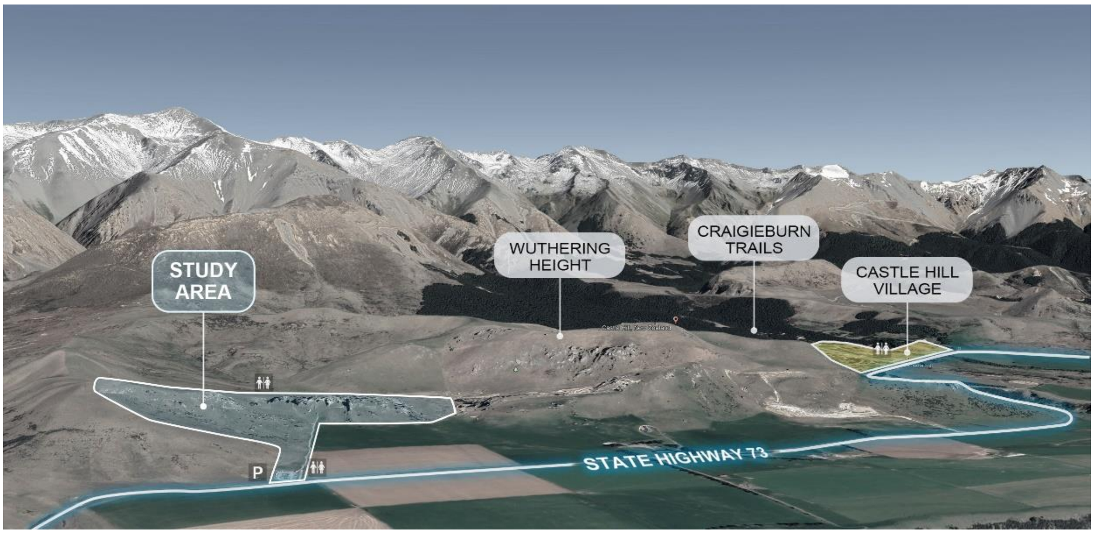

Figure 1-3 Study area location and context in 3D view

Figure 1-4 Kura Tāwhiti Castle Hill has long been popular for its distinctive sculptured landforms. Source: Author's photo, 2020.

However, with Kura Tāwhiti becoming more and more popular, its rising number of tourists and a series of problems that may be brought about in the future begin to concern many scholars (Apse et al., 2020). A recent ongoing study was set out by Dr Gillian Lawson and Yuqing He from Lincoln University to investigate tourists' perceptions of the rising visitor pressures and the resulting landscape changes, as well as how the changes might be mitigated through landscape architecture interventions[1].

1.1.3.2 Relationship between the ongoing study and this study

In 2019, a digital questionnaire of visitors was conducted at Kura Tāwhiti Castle Hill by the research team. A range of tourists' opinions was collected. These collected views were expected to inform the potential future developments and research on Kura Tāwhiti Castle Hill. Part of these collected views, particularly of what were considered the undesirable landscape elements, was adopted as the background of this dissertation. Some possible improvements to the identified undesirable elements were visualised by this dissertation as "practical" tasks, to test the visualisation techniques. The benefits of basing the dissertation on this practical background and collected survey data are twofold. Firstly, since this dissertation particularly focuses on the practical use of visualisation techniques, a near-practical background is required for examining the techniques' realistic effectiveness and efficiency. Secondly, since the tourists' perceptions of Kura Tāwhiti were well reflected by the survey, the survey-based visualisation works produced by this dissertation can be adopted for future research on Kura Tāwhiti Castle Hill to further investigate the tourists' opinions on this issue.

1.2 Research aim

The aim of the research is to exam the effectiveness (i.e., the capacity of producing high-quality visualisation) and efficiency (i.e., the ease of using the techniques) of a new strategy – combining modelled changed parts of the landscape with captured (photographed or filmed) unchanged parts of landscape settings – for producing photomontage, video simulations and panoramic (360-degree) video visualisations.

[1] Since the research on Kura Tāwhiti by Dr Gillian Lawson and Yuqing He is still in progress, it cannot be cited here. But the author's discussion and use of the relevant contents has been permitted by Dr Lawson.

1.3 Research structure

The following is a brief overview of the key points of each chapter to guide readers.

Chapter 2 reviews the relevant theories and concepts of how visualisation techniques have been applied to public participation in landscape planning and design. This chapter also reviews the challenges and gaps in the application of visualisation technology, and points to research questions at the end of this chapter.

Chapter 3 firstly explains the methods used in analysing the survey results obtained from the ongoing research and the way these results are used in this study. The chapter then explains the process of producing visualisation works and the way of acquiring production-relevant data. This chapter finally describes the method adopted for evaluating the visualisation techniques of photomontage, video simulations and panoramic videos.

Chapter 4 presents the visualisation works produced by using the selected techniques (photomontage, video simulations and panoramic videos) and evaluates both the effectiveness (i.e., the capacity of producing high-quality visualisation) and efficiency (i.e., the ease of using the techniques) of these techniques.

Chapter 5 discusses the application scope of the three visualisation technologies by comparing their effectiveness and efficiency. It also discusses the results in relation to other studies in reviewed literature and highlights the opportunities and challenges of applying visualisation techniques in public participation.

Chapter 6 concludes by claiming new knowledge from this research and highlights the limitation of this study, as well as the opportunities for future research.

Chapter 2
Literature Review

The chapter begins by explaining the concept of landscape visualisation and its significance in the landscape architecture field in Section 2.1. Following that, Section 2.2 outlines the history and development of landscape visualisation techniques. Section 2.3 presents the current practices of landscape visualisation, as well as the future trends suggested by a range of scholars. Section 2.4 reports the main challenges for applying new visualisation techniques into practices and the reason causing the challenges. The last section (Sections 2.5) identifies the main gaps in the current related research, and thus leads to the aims of this study, as well as three research questions of this study.

2.1 Landscape visualisation

Visualisation refers to techniques that help communicate information by creating images, charts, animations and so on (Hansen & Johnson, 2011). Landscape visualisation is a technique to explain proposed landscape changes in the form of visual information (Olsson, 2020). Visualisation has long been used in forestry, agriculture, alternative energy planning and so on (Lange & Hehl-Lange, 2005). In the field of landscape planning and design, landscape visualisation is widely used in the process of public participation (Lange & Hehl-Lange, 2005). In *Co-Design: A Process of Design Participation*, Stanley King et al. (1989) suggest that visualisation is the key to promoting effective public participation because it is the only common language among all participants. These "common language" provides a way to transform design and planning concepts into visual forms that are easier to understand (Coggan, 2007; Downes & Lange, 2015; Kwartler, 2005; Lange & Hehl-Lange, 2005; Lovett et al., 2015). McCormick, DeFanti, & Brown (1987, p. 3) describe landscape visualisation as "a method for seeing the unseen".

Scholars have discussed the contribution of landscape visualisation to the field of landscape planning and design. Mitchell (1977) pointed out that visualisation technology fundamentally changed the way of solving problems in the landscape architecture profession. Lange (2011) and Gill et al. (2013) suggest that the field of landscape visualisation has quickly developed in the last few decades. The use of visualisation techniques has grown from a near-zero baseline, and has now become a “standard in landscape research and practice” (Lange, 2011, p. 403). It is also suggested by Lange (2011) that the further development and application of landscape visualisation will promote the expansion of public participation, and therefore increase the chances for improving outcomes. According to Sheppard (2001, p. 194), landscape visualisations "provide the means for both an emotional (affective) response to proposed future environments and an analytical assessment of expected aesthetic changes". And he believes that landscape visualisation can contribute to making better decisions (2001). The necessity and benefits of applying visualisation techniques to the planning and design process are also highlighted by Lange (2011, p. 406): “we need a ‘playful’ and experimental approach to planning and design with an emphasis on involving relevant stakeholders early-on, thereby increasing the chances for improved outcomes”.

2.2 The history and development of landscape visualisation

2.2.1 The origin of landscape visualisation

The origin of landscape visualisation can be traced back to the 19th century when landscape architect Humphry Repton (1803) compared the proposed changes in the landscape for the first time in his famous "Red Books". The readers can turn the page between an existing landscape and a proposed landscape (as shown in Figure 2-1). The visualisation techniques in those days mainly included paintings, drawings and physical models (Lovett et al., 2015).

Figure 2-1 Before and after scenarios of Wentworth Yorkshire (adapted from Humphry Repton, 1803)

2.2.2 Digital landscape visualisation

The development and application of landscape visualisation benefited from the continuous improvement of computer processing power, hardware and software (Downes & Lange, 2015). The development of computer graphics and Computer-Aided Design (CAD) in the 1960s has greatly expanded the possibility of expressing landscape and environmental information (Danahy, 2001; Ervin, 2004; Orland et al., 2001). And CAD has been increasingly used in landscape planning and design since then (Sheppard & Salter, 2004). As landscape visualisation has been dramatically influenced by the application of CAD, the term “landscape visualisation”, nowadays, is often used to describe the representation of computer-generated landscape views (2004).

However, due to technical limitations and other reasons, the form of early CAD landscape visualisation was mostly in a two-dimensional view, such as plan view, section and elevation visualisation (Lange, 2001; Liu et al., 2016). Three-dimensional (3D) visualisation, such as terrain modelling, still largely relied on physical modelling, which was extremely time-consuming (Danahy, 2001). As a result, 3D visualisations were not commonly used in those days. Furthermore, the representation of landscape elements was often limited to the abstract geometric figures (e.g., square box for houses, abstract triangle for trees) (Lange & Bishop, 2001).

Since the 1990s, with the rise of Geographic Information System (GIS)-style software, manual terrain modelling was no longer needed for visualising the 3D environment (Ervin, 2004; Haeberling, 2002; Lange, 2001). Instead, 3D terrain can be automatically generated by simply importing Digital Elevation Model (DEM) data into GIS software (as shown in Figure 2-2). This has largely facilitated the application of 3D modelling techniques. In addition, some software specially designed for the landscape and related fields has also significantly facilitated the production process of landscape visualisation (Liu et al., 2016). For example, SketchUp, a 3D modelling software developed by the Last Software company, is famous for its simplicity and quickness in 3D modelling. Designers can easily master the software in a short period of time without systematic software training. It is considered one of the most commonly used software applications for landscape architects (2016). Moreover, the model databases of some software (such as Google 3D Warehouse) also provided designers with a wide range of ready-made 3D models (such as a range of vegetation models, transportation tools and outdoor facilities) for selection (Liu et al., 2016). This means that in many cases, landscape architects do not have to create every model for the landscape elements within their design by themselves (Liu et al., 2016). These are all the prerequisites for efficient and rapid development of 3D visualisation (Lange, 2001).

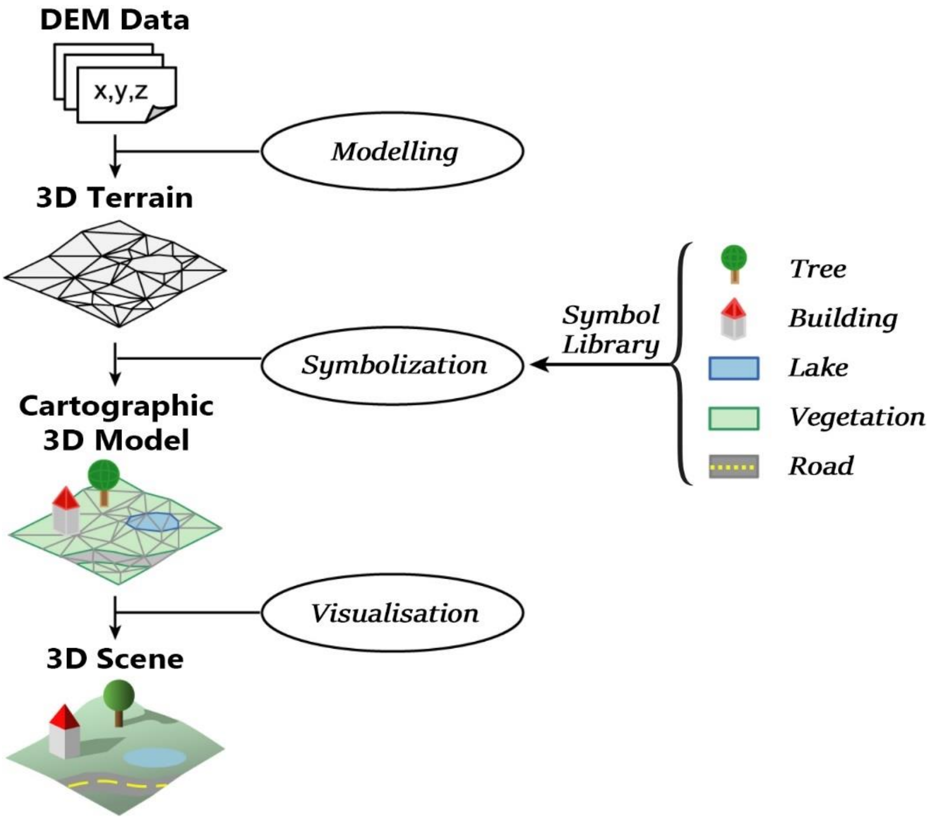

Figure 2-2 The process of visualising 3D environments by using GIS-style software (adapted from Haeberling (2002) and Terribilini (2001))

2.3 The applications and future trends of digital landscape visualisation

The consistent development of digital landscape visualisation techniques offers new possibilities for the publication participation practices in landscape design and planning (Liu, Zhang, & Li, 2016). With the continuous development of computer technology, visualisation gradually demonstrated a shift from two-dimensional to three-dimensional (Liu et al., 2016). More and more researchers believed that 3D visualisation was very important, and the transformation from 2D drawings to 3D scenes greatly improved the vividness and readability of display schemes (Liu et al., 2016). In addition, the visualisation techniques were not just limited to still images. Techniques such as video simulation and panoramic video simulation began to gain attention from scholars and professionals (Liu et al., 2016). Furthermore, some other scholars began to investigate the ways humans perceive a landscape (Lange, 2001).

According to Bruce, Green, and Georgeson, (2003), 80% of human perception is based on vision. However, other sensory, physiological and psychological factors also affect our perception of a place or of landscape elements. Moreover, because humans experience the world through three dimensions, in time and in motion, many scholars believe that visualisations that contain these elements are easier to understand and be accepted by the public (Kwartler, 2005). A study by Lindquist, Lange, and Kang (2016) investigated how audio elements affect participants' perceptions of a landscape. The researchers, Lindquist et al. (2016), combined different sound elements with landscape visualisations and then asked the participants to rate them. Finally, it was concluded that the change of sound could affect people's perception (Lindquist et al., 2016). The combination of appropriate sound and corresponding visualisation can more accurately simulate the human experience and significantly improve the authenticity of landscape experience (Lindquist et al., 2016).

2.3.1 Animation and video simulations

Animations and video simulations are a type of visualisation technique that allows users to "walk through" or "fly-through" a proposed design (Dransch, 2000; Liu et al., 2016). This type of visualisation can provide audiences with richer information about the landscapes to be communicated, other than simply static visual information (Dransch, 2000; Liu et al., 2016). Audio information, as well as spatial and temporal experience, were also communicated by such techniques (Dransch, 2000; Liu et al., 2016). This can greatly arouse audiences' interest and attention (Dransch, 2000; Liu et al., 2016). All these different types of information and experience were combined and communicated together in a video (Coggan, 2007). This could help audiences to gain and understand more information in a shorter period of time, which is considered a vital requirement for visualisations today (Coggan, 2007). It is suggested by Tress and Tress (2003) that "digital video technique could become an important tool in the future as it combines the contriteness of photos with the dynamism of computer simulations".

2.3.2 Panoramic visualisation

Apart from the application of animation and video simulation techniques, the panoramic experience is another trend for future landscape visualisation. Panoramic visualisation, also known as immersive visualisation, or spherical visualisation, is a type of visualisation technique which can provide the audience with a view in every direction of a landscape (Nakame, Qin, & Tadamura, 2004).

It is suggested by many that panoramic visualisations are more effective in communicating an existing or a proposed landscape (Buchan & Heritage, 2002; Downes & Lange, 2015; Nakame et al., 2004). Firstly, it is suggested that panoramic visualisation conforms better to the human eyes' function (Downes & Lange, 2015). According to Downes and Lange (2015, p. 137), the human eye is "both a very wide photographic lens and a telephoto lens". Therefore, when experiencing a landscape on-site, the acquired visual information is unlimited and seamless (2015). However, when communicating a landscape by traditional visualisation techniques, the audience is normally limited by "the fixed physical boundaries of the printed or projected format" (2015, p. 137). Therefore, the experience offered by a traditional visualisation is very different from the experience acquired by viewing an environment on-site (2015). According to Buchan and Heritage (2002, p. 17), "Partial views of objects or lack of contrast can lead people to 'see' an object and still fail to perceive the object". In contrast, panoramic visualisations can provide audiences with unlimited and seamless views of a landscape (Downes & Lange, 2015). It therefore offers a near-real visual experience (Nakame et al., 2004). It is suggested that panoramic observation is "much more useful than a set of standard size still images" (2004, p. 226).

Secondly, panoramic visualisation, "with a rotatable, realistic, eye-level view of the landscape" can also better attract the audiences' interest and they are, therefore, more likely to devote more effort to acquire the information about the landscape to be communicated (Warren-Kretzschmar & Von Haaren, 2014, p. 437).

Thirdly, when using a Virtual Reality (VR) technique along with the panoramic visualisation techniques, a more realistic and immersive experience can be provided (Ervin, 2004; Miller et al., 2016). Some studies use head-mounted displays, such as VR headsets to provide participants with an immersive experience environment (Miller et al., 2016; Paar, 2006). Some landscape firms or research institutions have even been equipped with professional touch screens and a virtual reality theatre to display the final visualisation results, which can not only provide a better sensory experience for viewers but also allow multiple people to watch together and conduct group discussion (Ervin, 2004; Miller et al., 2016; Portman, Natapov, & Fisher-Gewirtzman, 2015; Wang, Miller, Brown, Jiang, & Castellazzi, 2016).

2.4 Video simulation and panoramic visualisation remains rare in practice

Despite advantages argued by scholars, the use of video simulation and panoramic visualisation techniques remains rare in practice. According to Lovett et al. (2015), photomontage, the visualisation technique invented in the 1960s, remains one of the most widely used techniques for communicating landscape architecture designs. There are mainly two factors preventing the use of video simulation and panoramic visualisation techniques, which are suggested by a range of scholarly publications.

2.4.1 Insufficient visualisation quality

It has been suggested that in many cases, the visualisation quality achieved by using video simulation and panoramic visualisation is still insufficient (Buhmann et al., 2003; Ervin, 2001; Lange, 2001).

Most video simulations and panoramic visualisations produced in practice today are based on 3D modelling. The most typical workflow of such visualisation is firstly creating or adopting 3D models and then rendering the complete 3D model. However, there remains a technical difficulty in both steps today. Firstly, according to Ervin (2001), there are six essential landscape elements: landform, vegetation, water, structure, animals, atmosphere. These elements have a crucial impact on whether visualisation can provide audiences with an experience that is close to reality (Ervin, 2001; Lovett et al., 2015; Steinitz, 2012). However, in the modelling process, many typical landscape elements (such as animals and vegetation) in practice are “fuzzy, curved, complex and dynamic” (Ervin, 2001, p. 55).

These elements remain very difficult for modelling today (Ervin, 2001). Furthermore, in the case of video simulation, the behaviour and action of many landscape elements (such as animals, dynamic water and vegetation) need to be demonstrated. These behaviours and actions are even more difficult to represent by using modelling techniques today (Ervin, 2001).

In addition, one of the most important landscape elements – topography – is also challenging for modelling (Buhmann et al., 2003; Coggan, 2007; Lange, 2001). According to Lange (2001), the most commonly used techniques for topography modelling today are GIS-based visual simulation techniques. However, the application of this technique is largely limited by the availability of DEM data. According to Lange (2001) and Buhmann et al. (2003), DEM data is often unavailable. In New Zealand, although some types of DEM data collected by various agencies are available for free downloading from online platforms like Land Information New Zealand (LINZ) and Land Resource Information System (LRIS) Portal, the types of DEM data are still limited, or sometimes, the data are in insufficient resolutions. If data are strongly required for some particular purposes, the data collecting activity is often extremely costly and unaffordable in terms of the research budget of a university (Buhmann et al., 2003).

Finally, the existing rendering techniques are also limited in communicating the atmosphere of a landscape. It is suggested by Ervin (2001) that the atmosphere, including lighting, fog, haze, wind and clouds, can significantly enhance the experience that visualisation can offer and make it more realistic and evocative. However, existing visualisation techniques cannot easily simulate the actual atmosphere of a landscape (Ervin, 2001). Thus how to capture those parts of a landscape that represent the atmosphere or character of a place in a cost effective way needs to be investigated.

2.4.2 Time-consuming and difficult to learn

In addition to the insufficient visualisation quality, video simulation and panoramic visualisation techniques are not attractive and “smart” enough for producers to use. In 2006, Paar conducted a survey to investigate the factors which encouraging and preventing visualisation producers to choose a visualisation technique. The survey result shows factors such as time-consuming production, the difficulty of learning, and difficult operability are important factors that prevent the application of a visualisation technique (2006). However, it has been suggested that the production of digital video simulation is time-consuming (Tress & Tress, 2003). Moreover, MacFarlane et al., (2005) and Sheppard (2001) suggest that there is still a lack of guidance on production methodology, as well as of assessment criteria. This makes such techniques more difficult to learn and operate. Bishop and Lange (2005a, p. 76) argued that “we have to make our simulation smarter”.

Therefore, in addition to the visualisation quality mentioned in Section 2.4.1, another key factor affecting the application of video or panoramic video visualisation needs to be discussed from the perspective of the producer. And the producer's choice to use a visualisation often depends on whether the technology used to realise this visualisation is "efficient" (i.e., the ease of using the techniques).

2.5 A possible strategy to overcome the barriers

According to the discussion above, it is not difficult to find that the biggest barrier in the application of video simulation and panoramic visualisation techniques lies in the insufficient visualisation quality caused by the unsatisfied 3D modelling and rendering techniques and the low ease of use of the techniques. Little is known about the differences between visualisation techniques from the producer’s perspective.

There is an opportunity to minimise or avoid the 3D modelling and rendering process, the most problematic part of the workflow. Bishop and Lange (2005b) questioned the way landscape visualisations are made today in their publication “Visualisation Prospects”: “Why should we take the trouble to model those components of the landscape that are not changing? […] Why should we not use imagery of the existing landscape and only use computer graphics to represent the areas of change?” A key message offered by Bishop and Lange (2005b) is that instead of modelling and rendering the whole landscape, we probably can just model and render the changed part of the landscape and combine them with photographs or films of the unchanged landscape. Similar views are also expressed by Danahy (2001) and Paar (2006), who suggested that much of the explicit and realistic information, such as leaf texture in 3D plant models, should be sampled from the real world instead of computed.

Combining the designed elements with a captured, unchanged part of a landscape is considered a trend for visualisation in the future (Bishop & Lange, 2005b). Although this production strategy has great possibilities to help visualisation producers to minimise or avoid the most problematic part of the visualisation process, there is little research investigating how to combine designed elements with the captured unchanged parts of a landscape.

Therefore, this research focus on the following three research questions:

1. Can effective visualisation be achieved through combining the designed elements with the captured unchanged parts of a landscape?

2. In comparison with photomontage, the visualisation technique that is most commonly used, what are the advantages and disadvantages of the production strategy illustrated above?

3. What are the differences of these three visualisation techniques from the producer's perspective?

Chapter 3
Method

This chapter starts by outlining the overall process of the research in Section 3.1. The survey methods used by Dr Lawson and her team to investigate visitors to Kura Tāwhiti Castle Hill are described in Section 3.2 to provide some background information. Section 3.3 describes the methods this study used to analyse the survey results, before moving to Section 3.4, which explain the methods used to create the visualisation works. Section 3.5 describes the methods used to evaluate the created visualisation works.

3.1 The process of the study

As mentioned in Section 1.1.3, the development of this research was based on an ongoing research project conducted at Kura Tāwhiti. A survey of the Kura Tāwhiti tourists was conducted to understand the tourists' perceptions of the landscape, the rising visitor pressures and different future development scenarios for Kura Tāwhiti.

Among the survey questions, one question collected tourists' opinions on undesirable factors they experienced during their visit to Kura Tāwhiti. The result of this survey question actually signals the landscape elements that need improvement. Therefore, this study first analysed this survey question to identify three possible improvements that were most needed by the site. The possible improvements were then adopted as the visualisation tasks to test selected visualisation tools. By visualising the proposed changes, the application scope of the selected visualisation tools was finally examined by evaluating the effectiveness of the visualisation works produced, as well as its efficiency through the recorded workflow in the production process. Figure 3-1 shows the detailed process of this research.

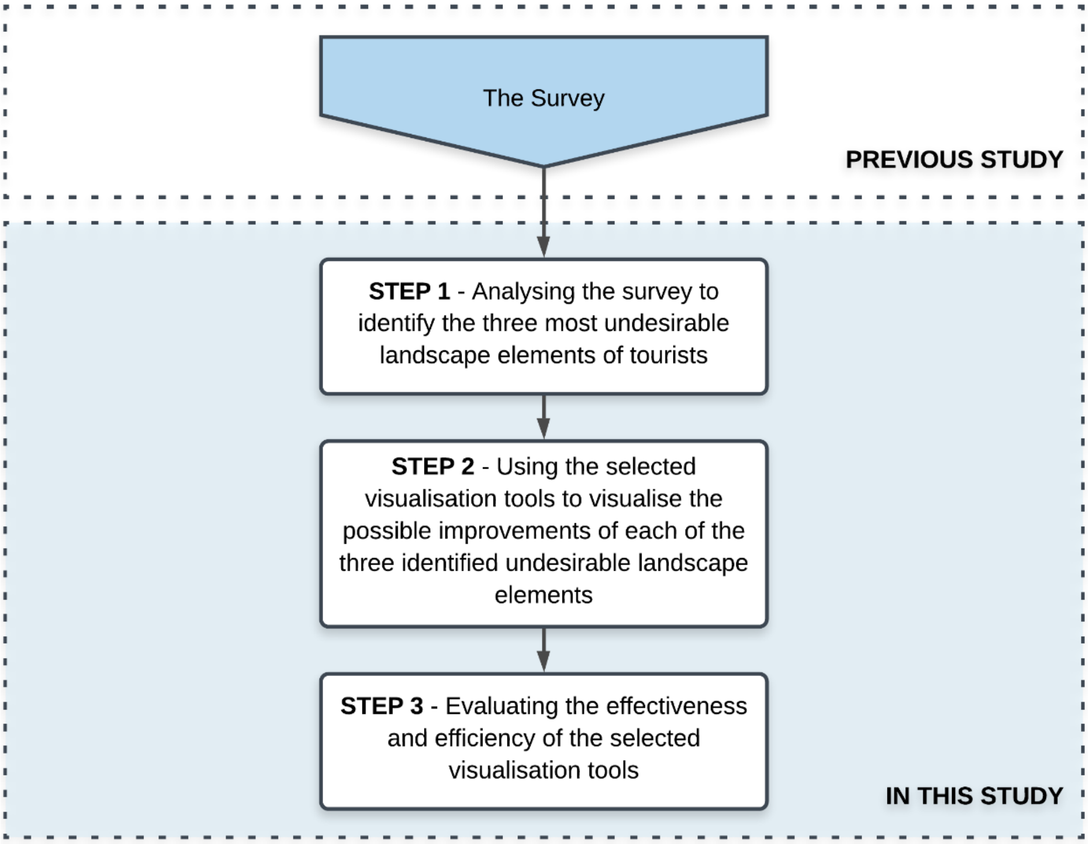

Figure 3-1 Research process

3.2 Survey methods used by the original research

To encourage tourists' participation, the survey was conducted near the entrance of Kura Tāwhiti where every tourist has to pass to visit the site. A tent was also set up in the survey area, with table and chairs provided inside to provide the participants with a comfortable environment to complete the survey questionnaire. Furthermore, a poster with survey links was posted near the entrance to encourage tourist participation beyond the on-site surveying period. The tourists who were interested in the survey were able to complete the survey on their own electronic devices by just scanning the QR code on the posters.

The on-site survey was intended to be conducted at the peak time of tourists visiting Kura Tāwhiti, that is, peak season (from November to

December), weekends, and fine days. This helped the researchers to collect as many responses as possible. The actual on-site surveys were conducted on 16th, 17th, 23rd, 24th, 30th November, and 1st, 7th, 8th December in 2019.

The selection of participants was based on the principle of ensuring voluntary participation. The total sample of the study included 151 New Zealand domestic visitors. A total of 35 questions were included in the survey, which took about 15 minutes for participants to complete. These questions included four sections: The first section was mainly used to ensure that the participants were the target group, identifying, for example, whether they were over 18 years old, or whether they were a domestic tourist and so on. The second section was to investigate the background information of the participants (such as education, ethnic group, gender, etc.). The third section was to investigate the tourists' perceptions of the current situation of Kura Tāwhiti, including desirable and undesirable factors. And these questions were open-ended. The fourth section investigated the tourists' perceptions of Kura Tāwhiti's possible future conditions.

3.3 Analysing the survey

In this study, the relevant parts of the questionnaire were analysed in order to carry out further research based on these investigations. In the first step, the tourists' background information, including gender, educational qualification and so on, were analysed and exported from Qualtrics to provide an overview of the participants' distribution. The researcher then analysed the result of a survey question about the undesirable factors of Kura Tāwhiti Castle Hill identified by the participants. Since this question was open-ended (i.e., the survey response was textual data), a coding method was used to analyse the textual results. As shown in Appendix A, the textual data were simplified and categorised to extract the key views. Through coding, a series of undesirable factors were identified from the tourists' answers (as shown in Section 4.1.2). The top three undesirable landscape architecture-related elements (based on the frequency of being mentioned in responses) (as shown in Table 4-1) were marked out and considered for improvement. Possible improvements were then visualised as per the methods explained in the next section.

3.4 Visualising the possible improvements to the identified undesirable landscape elements

In the second step, each of the three proposed landscape improvements was visualised by using the three selected visualisation tools. This means that for the same improvements, there were three different versions of visualisation works produced by using different tools. This forms a comparable baseline for evaluating the produced visualisation works and selected tools. The produced visualisation works were examined in the next step to evaluate the effectiveness of those visualisation tools.

Three visualisation techniques were selected to visualise the proposed improvements. As explained in Section 2.4, the future trend of landscape visualisation is to place the modelled and rendered changed part of the landscape into captured (photographed or filmed) unchanged landscape settings, rather than take the trouble to model the whole landscape – both the changed and the unchanged landscape elements (Bishop & Lange, 2005b). Therefore, the visualisation tools that were selected for testing in this research used the methods that place the modelled and rendered changes into the captured unchanged landscape settings.

The selected visualisation techniques include photomontage, video simulations and panoramic video simulations. These three visualisation techniques work in similar ways. As shown in Figure 3-2, the unchanged landscape and the proposed change in the landscape (the computer-generated signage in this example) were obtained separately. While the unchanged part of the landscape settings are captured (or digitised) by photographing or filming, the proposed changes were acquired from several different ways such as 3D modelling, photographing or even hand-drawing. These two parts of the landscape are then combined by using different computer programmes. (The process of combining the two parts is explained in Section 3.4.3 in detail). The fundamental differences between the three selected techniques are that the unchanged parts were captured differently – in the form of photo, video and panoramic video, respectively. This will be further explained in Section 3.4.1.

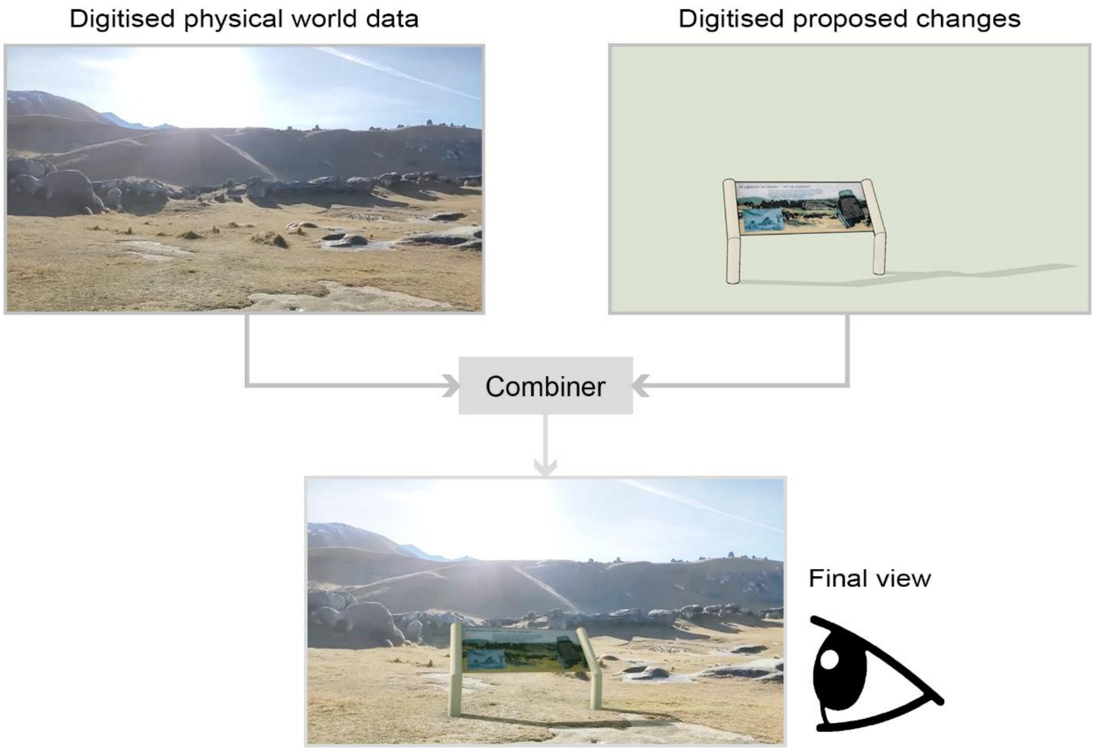

Figure 3-2 An example of producing visualisation works in this study (the detailed process of combining the two parts is explained in Section 3.4.3)

3.4.1 Digitising[2] the unchanged landscape setting

As explained in the last section, the first step of visualising proposed changes is to capture a digital representation of the landscape setting – the unchanged part of the landscape visualisation. In general, when the proposed landscape intervention is determined, the surrounding environment (i.e., the unchanged part of the landscape) of the proposed development will then be digitised. Section 4.2 introduces the location and the decision-making of proposed improvements to the three identified undesirable landscape elements.

In this research, three different digital devices were used for digitising[2] the landscape setting – camera (for photomontage), camcorder (for video simulations) and 360-degree camera (for panoramic video simulations).

[2] "Digitising" refers to the process of converting visual information into a digital form that can be processed by computer programs.

The device name and relevant technical parameters (specifications) are shown in Table 3-1.

Table 3-1 Names and technical specifications of digital devices used in digitising the unchanged landscape setting

	Camera	**Camcorder**	**360° camera**
	 Canon EOS 700D	 Canon HFR806	 Samsung Gear 360
Resolution	5184 × 3456	1920 x 1080	4096 x 2048
CMOS sensor	22.3 × 14.9 mm	1/4.85"	1/2.3"
Aspect ratio	3:2	16:9	2:1
Lens	EF-S 18–55mm	2.8mm - 89.6mm	Dual Fisheye Lens

Besides the devices used and its' technical specifications, there are also some site-specific requirements for filming and photographing. According to Ervin (2001), the three quintessential elements for creating a landscape visualisation are landform, vegetation and water, which defines the “signature” of a landscape. The characteristic of a landscape cannot be represented without including these three elements in a landscape visualisation. In the context of Kura Tāwhiti, no obvious surface water was observed. Therefore, the main elements to be captured are landform (including topography and those highly characterised rocks) and vegetation (as shown in Figure 3-3). This means that every photo or video captured should contain at least these two elements to ensure its representativeness as the visualisation material of Kura Tāwhiti.

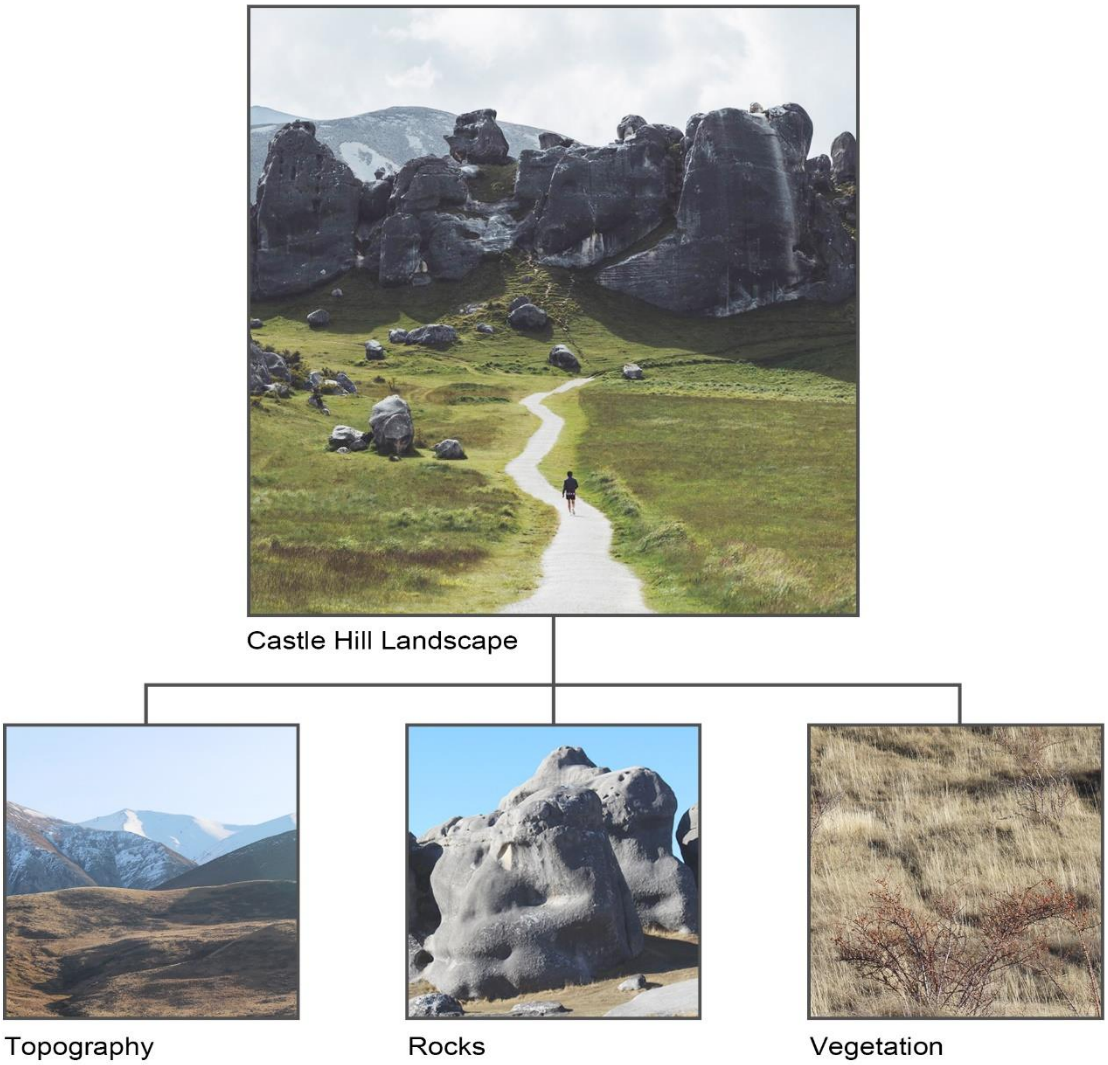

Figure 3-3 The main elements that need to be captured at Kura Tāwhiti are topography, highly characterised rocks, and vegetation to ensure its representativeness as the visualisation material of the site.

3.4.2 Digitising the proposed changes

The second step of visualising proposed improvements is to translate the conceptual proposal of landscape changes into a representational digitised file. As shown in Figure 3-2, there are several different ways for digitising proposed changes. The methods used in this research are to adopt existing 3D models and adopt an existing image. The researcher acquired several 3D models and images that were in accord with the characteristics of the proposed changes from online databases. These digital files (3D models and images) were then adopted to represent the proposed landscape changes.

3.4.3 Combining the proposed changes with the digitised landscape setting

As shown in Figure 3-2, the digital files (3D models and images) acquired in the second step were then placed in the digitised landscape setting captured in the first step by using several different software and plug-in.

Firstly, as for the photomontage, the researcher combined the photos of unchanged landscape captured in the first step with the proposed changes digitised in the second step by using Adobe Photoshop software. Following that, the photomontages were made more realistic by adjusting parameters like light and brightness and adding in some other elements like people. The programme used for producing video simulations, differently, were Adobe After Effects (AE) and Element 3D (E3D) plug-in. By using these programmes, the captured video footage and computer-generated 3D models of proposed changes were combined. As the producing process is relatively complex, the producing process will not be explained in detail here. (For more details, refer to the video tutorial produced by 3DSINGH[3]). Similarly, the producing programmes of panoramic video simulations are AE and E3D as well. However, as the video captured for panoramic video simulations are all panoramic footage, an additional plug-in, VR Comp Editor, is required to process the footage. For more details of producing panoramic video simulation, refer to video tutorial published by Charles Yeager[4].

3.4.4 Collecting relevant workflow information

As explained in Section 2.5.2, the effectiveness (such as accuracy, representativeness and interest) of a visualisation technique is not the only consideration for designers/planners to use this tool (Bishop and Lange, 2005). The efficiency, as another key consideration of a visualisation producer for using a technique or not, was reflected by the workflow of a

[3] The links for the video tutorials are as follows:
Producing video simulations: "How to add 3d object in video: After Effects tutorial By 3DSINGH" (3DSINGH, 2019): https://www.youtube.com/watch?v=R3dU2oQ67Xw
[4] Producing panoramic video simulations: "How to Use the VR Comp Editor in After Effects with 360° Video" (Yeager, 2018): https://www.premiumbeat.com/blog/vr-comp-editor-360-video/

visualisation technique. Therefore, information about the producing workflows was also recorded in the production process to analyse the efficiency of the selected visualisation techniques from the producer's perspective. As explained in Section 2.4.2, a survey was carried out by Paar (2006) to investigate the factors which affecting visualisation producers to choose a visualisation technique. Eight factors were identified as the most important consideration of producers. Among the eight considerations, most were in relation to the production workflow. These considerations include financial cost, ease of data exchange with other computer programmes, ease of learning, ease of operating and rendering speed. This information was collected during the production process. The type of information collected are:

› required software (e.g., Adobe Photoshop CS5 or newer version, SketchUp 10 or newer version, Adobe After Effects 2020 or newer version), as well as their price;

› required data (e.g., photos, video footage, 3D models), the format of these data, as well as the data compatibility with other computer programmes;

› time needed for learning the software required for adopting a visualisation (accounted in minutes);

› time needed for producing a visualisation, including the time needed for collecting required data, as well as the time for producing the visualisation (accounted in minutes);

› time needed for rendering (accounted in minutes).

The collected workflow information is reported in Section 4.2.

3.5 Evaluating the effectiveness and efficiency of the selected visualisation tools

In the final step, the generated visualisation works and the collected workflow information were analysed to evaluate the effectiveness, efficiency, and the application scope of the three selected visualisation tools. What needs to be clear is that since the research was desk-based, these evaluations were conducted by the researcher's observation and reflection rather than through empirical fieldwork with visitors or with stakeholders at the Kura Tāwhiti.

According to Sheppard (2001), five principles – accuracy, representativeness, visual clarity, interest, and legitimacy should be considered when producing visualisation works. This is considered as the most classic (and almost the only) sets of principles for landscape visualisation at present (Bishop & Lange, 2005a; Downes & Lange, 2015; Olaf Schroth, 2010). These principles were adopted by this research to examine the visualisation works produced in the previous step, and therefore, indirectly evaluate the effectiveness of the selected visualisation tools. "Accuracy" refers to the principle that "visualisation works should simulate the actual or expected appearance of the landscape as closely as possible" (2001, p. 196). "Representativeness" refers to the principle that "visualisations should represent the typical or important range of views, conditions, and time-frames in the landscape which would be experienced with the actual project, and provide viewers with choice of viewing conditions" (2001, p. 196). By "Visual clarity", Sheppard (2001, p. 196) means "the details, components, and overall content of the visualisation should be clearly communicated". "Interest" refers to the principle that "the visualisation should engage and hold the interest of the audience, without seeking to entertain or 'dazzle' the audience" (2001, p. 196). And finally, "legitimacy" refers to the principle that "the visualisation should be defensible through making the simulation process and assumptions transparent to the viewer, and by clearly describing the expected level of accuracy and uncertainty" (2001, p. 196). Besides, due to the qualitative nature of this research method, the focus of this research is not to compare which tool is better, but to interpret and discuss the advantages, disadvantages and applicable conditions of these tools through the principles of the above five dimensions. The concluded effectiveness is presented in Section 4.3.1.

As for the evaluation of the efficiency of the selected tools, it was based on the recorded relevant workflow information as mentioned in Section 3.4.4. The concluded efficiency is reported in Section 4.3.2.

Finally, according to the effectiveness and efficiency acquired, the application scopes of the three selected visualisation tools were suggested. The suggested application scopes are presented in the discussion Chapter.

Chapter 4

Results and Findings

This chapter presents the results and findings acquired from this study. Section 4.1 reports the survey question's analysis of respondents' background information and their identifications of undesirable elements in Kura Tāwhiti Castle Hill. The top three undesirable landscape architecture-related elements are marked out at the end of this section as the task of visualisation. In Section 4.2, possible improvements are introduced based on the survey results. The visualisation results and the evaluation of these visualisation results are presented in Section 4.3.

4.1 Survey results

4.1.1 Background information of respondents

By the end of the survey period, data had been collected from 151 individuals, of whom the responses of 133 (88%) were suitable.

As shown in Figure 4-1, of the 133 participants, 42% were male, while 56% were female.

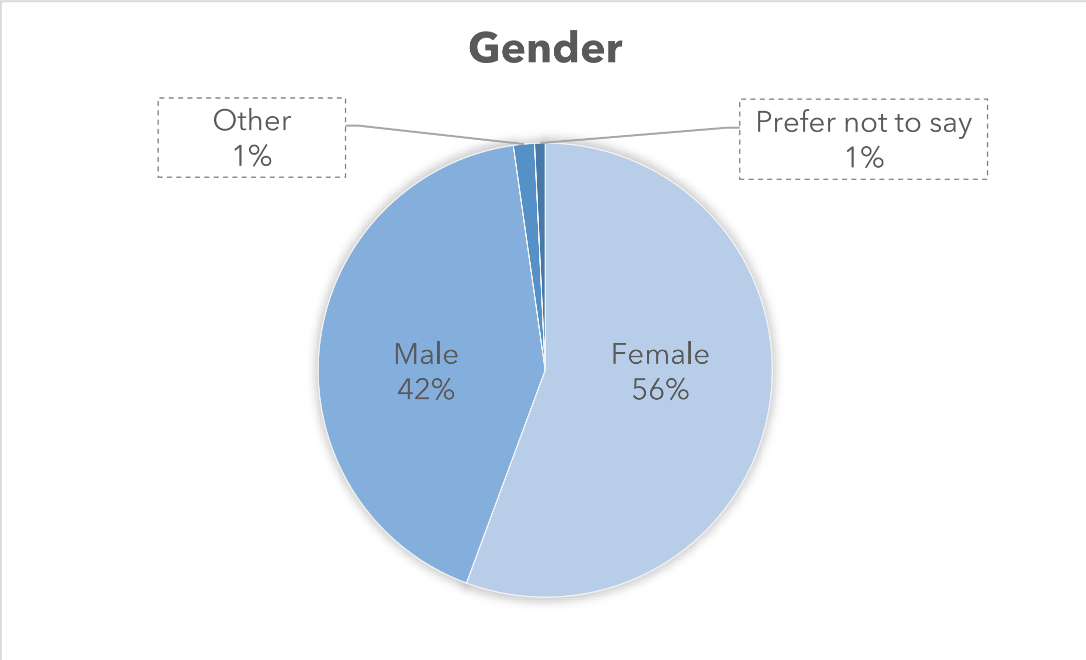

Figure 4-1 Gender proportions of the participants (n = 133)

In terms of the educational background of the participants, as shown in Figure 4-2, more than two-thirds (68%) of the respondents have undergraduate or higher degrees.

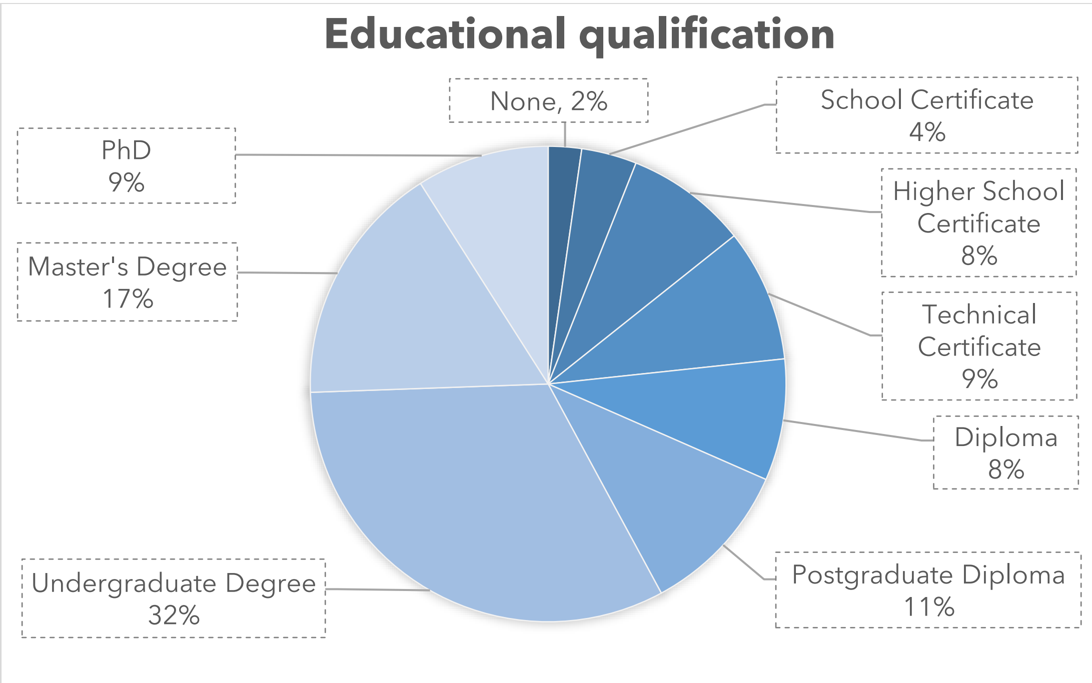

Figure 4-2 Education qualification of the participants (n = 133)

As shown in Figure 4-3, among the participants, approximately two-thirds (64.4%) were repeat visitors.

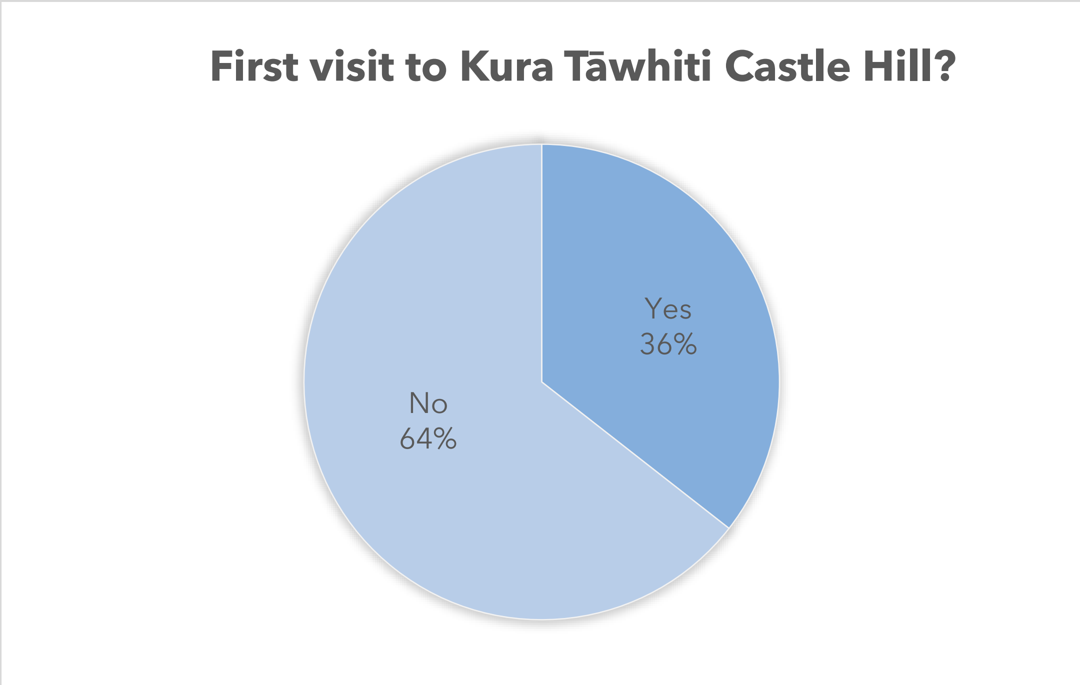

Figure 4-3 Proportions of first-time visitors and repeat visitors (n = 133)

4.1.2 Tourists' perceptions of the current situation of Kura Tāwhiti Castle Hill

This section reports on the survey results of one of the survey questions: "What did you like LEAST about Kura Tāwhiti Castle Hill?". As these questions are open-ended, the textual data collected were coded as per the method explained in Section 3.3. The coding records are shown in Appendix A.

In response to the question "What did you like LEAST about Kura Tāwhiti Castle Hill?", the key undesirable elements emerged, as shown in Table 4-1. There were 122 responses in total to this question, among which two were invalid due to irrelevance to the question asked. Among the remaining 120 valid responses, 35 (29%) responses indicated that there are no undesirable elements in Kura Tāwhiti, while 28 types of undesirable elements were identified from the other 85 responses. Among the 28 undesirable elements, twelve can be addressed by landscape architecture or planning interventions. These elements are marked by "•" in Table 4-1. "Lack of signs", "lack of trees" and "muddy" were considered as the three most undesirable landscape-resolvable elements.

Table 4-1 Tourist-identified undesirable elements in Kura Tāwhiti

	Count	(%)
Nothing	35	29
Too many people	21	18
Busy car park	7	6
Lack of signs •	7	6
Too steep	6	5
Bad weather	6	5
The trees are gone	6	5
Rubbish	5	4
Graffiti on the rocks	5	4
Flying of drones	3	3
Lack of trees •	3	3
Muddy •	2	2
Animal waste	2	2
No running water •	2	2
Erosion •	1	1
Nothing too much to watch or do •	1	1
Restroom facilities •	1	1
Road noise •	1	1
No drinking water •	1	1
Unsafe	1	1
Weeds •	1	1
Bad language from people bouldering	1	1
Close to the road	1	1
No pub •	1	1
Not enough time to spend here	1	1
Bouldering	1	1
Scenery •	1	1
Polished rock	1	1
Buses	1	1

•: Elements that can be addressed by landscape architecture or planning interventions

4.2 Proposed improvements to the three identified undesirable landscape elements

4.2.1 Signage

According to the feedback on the lack of signage from the participants, the researcher investigated the existing distribution of signage on site during a site visit. It was found that there is only one signage on site, which is located near the entrance of the Kura Tāwhiti Castle Hill track. Basic information about the site location and a brief history of the site is provided by the signage. However, there is neither path signage on-site, nor other signage that provides further site information. Through on-site investigation and map analysis, it is considered that signage was also necessary at some main intersections and some areas where tourists tend to linger[5]. These areas are indicated in Figure 4-4. One area (as shown in Figure 4-4) was randomly chosen by the researcher as an example of a visualisation task to test the visualisation tools.

[5] Since the focus of this study is the application of visualisation techniques in landscape architecture, the specific planning and design questions are beyond the scope of this study. Therefore, only brief rationales are explained here to justify the proposed landscape interventions.

Figure 4-4 The location of the three proposed improvements

4.2.2 Vegetation

The second most undesirable landscape architecture-relevant elements identified from the survey result is "lack of trees". By conducting background research, it was determined that it is barely possible to plant trees on the conservation area of Kura Tāwhiti Castle Hill site since the landscape within the conservation area was classified as Outstanding Natural Landscape (ONL) under the Resource Management Act 1991 (Environment Canterbury, 2010). However, it is possible to plant some trees near the entrance area of the track (as shown in Figure 4-4), where many visitors linger for a while, waiting for someone who is using the toilet nearby, approaching from the car park nearby or reading the entrance signpost. Therefore, the second proposed improvement is to plant some trees near the entrance area[6].

4.2.3 Stone paving

The third identified undesirable landscape element was "muddy". This is also experienced by the researcher during the site visits. The muddiest area on site is indicated in Figure 4-4. The primary reasons for the muddy ground are the fragile land cover there and the frequent trampling by visitors. With the increase in the number of tourists in Kura Tāwhiti, the land cover on that area was almost worn out and only loose soil was left. As a result, the area remains muddy for days or even weeks after every rainfall. To address this issue, this study proposes to lay the flagstone pavement similar to the colour and shape of the existing rocks in Kura Tāwhiti to visualise an example of the proposed scheme[7]. The proposed pavement will not only provide the visitors with a more stable and firm walking surface but also help limit visitors' trampling within the paved area and help with the recovery of the land cover in that area.

These three proposed improvements were visualised by using the three selected visualisation tools. The produced visualisation works are presented in the next section.

4.3 Evaluation of the visualisation tools

As per the method explained in Section 3.5, the evaluation of the visualisation tools was conducted from two perspectives – effectiveness and efficiency. Section 4.3.1 reports the evaluation results of the effectiveness of the visualisation tools, while Section 4.3.2 presents the results on the tools' efficiencies.

[6, 7] Again, the specific planning and design questions are beyond the scope of this study. Only brief rationales were explained here to justify the proposed landscape interventions.

4.3.1 Effectiveness

As explained in Section 3.5, the effectiveness of the visualisation tools (represented by the effectiveness of the visualisation works produced by those tools) was evaluated according to a set of general visualisation principles established by Sheppard (2001). Five principles – accuracy, representativeness, visual clarity, interest, and legitimacy should be considered when producing visualisations, and hence the visualisation works produced were evaluated against these five principles.

4.3.1.1 Photomontage

This section evaluates the visualisation works produced by using the photomontage tool (as shown in Figures 4-5, 4-6 and 4-7). (The methods of producing these photomontages are explained in Section 3.4).

Figure 4-5 Photomontage of the proposed signage

Figure 4-6 Photomontage of the proposed trees

Figure 4-7 Photomontage of the proposed flagstone paving

a) Accuracy

As explained in Section 3.5, "accuracy" refers to the visual similarity between visualisation and actual landscape appearance (Sheppard, 2001). Reflecting on the three visualisation works produced, relatively high accuracy was achieved.

There are several different factors affecting the accuracy of such photomontage works. Firstly, the realness of the adopted image materials is a major factor affecting the accuracy of visualisation. Since most of the elements that were placed in the three photomontages produced are photographed image materials with highly realistic appearance (such as the signage in Figure 4-5 and all the tourist images); an overall realistic appearance is achieved by these visualisations. However, since the trees in Figure 4-6 and the flagstone paving in Figure 4-7 are not photographed image material, the level of the realness of these two visualisation works was lowered. Secondly, the lighting level of different image materials was also vital for achieving a high level of realness. The lighting parameters (such as brightness, hue, and contrast) of the image materials were carefully adjusted before they are combined. This means that the lighting parameters of all the image materials in the photomontages were adjusted to similar levels. Therefore, an overall higher level of harmony is achieved in these three works, which contributes to the accuracy of these three visualisations. Finally, the scale of the elements that were placed in was vital for the accuracy of visualisation work. The adjustment of the relative scales of the image materials fully depended on the visualisation producer's understanding of three-dimensional structures and spatial perspectives. For example, to make the photomontages perspectively sound, the elements with the same height should be organised to make sure their tops were on one horizontal line (e.g., the top of human elements should be placed roughly on the same horizontal line if the intention is to show that these "characters" were standing on the same level). The scales and places of all the image materials added in these three photomontages have been carefully adjusted. This makes these visualisations perspectively more accurate.

Therefore, in summary, if all these three factors were carefully handled, an overall high accuracy can be achieved by using the photomontage tool. In other words, as a visualisation tool, photomontage is capable of producing highly accurate visualisation works.

Compared with some other visualisation techniques, however, (such as 3D modelling, which requires little knowledge of spatial perspectives to produce a highly accurate visualisation work) the actual accuracy of photomontage work relies heavily on the technical sophistication of the visualisation producer. In addition, the photomontage tool is relatively easy for manipulating visualisation works, which lowers the visualisation accuracy purposely. Issues related to visualisation manipulation are further discussed in Section 4.3.1.1.e.

b) Representativeness

As explained in Section 3.5, "representativeness" refers to the principle that the typical range of views, conditions, and time-frames of a landscape should be represented by visualisation, and "provide viewers with choice of viewing conditions" (Sheppard, 2001).

Reflecting on the three photomontage works produced (as shown in Figure 4-5, 4-6 and 4-7), generally, the "typical" and "important" visual elements were represented. For example, the three photomontages represent the views from human eye level (as tourists would see), and the views on a sunny day (the time that tourists would most likely visit the site). This makes these photomontages of relatively high representativeness. However, when compared to the other two visualisation tools – video simulation and panoramic video simulation, the works produced by a photomontage tool can only represent the status at one moment of time and the view of visual elements in a solid perspective (view the landscape from one static position). For example, since the signage in Figure 4-5 is represented from a solid perspective, the visualisation audience can only get a sense of how the signage looks like from the front, but cannot work out how the signage looks like from behind. In the example of flagstone paving, the photomontage only represents the view of the paving from a certain perspective. As a result, the audience can barely get a sense of information such as how the paving looks like from a distance and how long the stone path would be.

c) Visual clarity

As explained in Section 3.5, "visual clarity" refers to the principle that "the details, components, and overall content of the visualisation should be clearly communicated" (Sheppard, 2001).

Since the three proposed improvements (signage, trees and flagstone pavement) are simple in form and structure, a relatively high visual clarity was achieved. However, compared with the video simulation tool and the panoramic video simulation tool, fewer details were contained in photomontages. This will be further discussed in Section 4.3.1.1.e.

d) Interest

As explained in Section 3.5, "interest" refers to the principle that visualisation should be able to arouse the interest of the audience, "without seeking to entertain or 'dazzle' the audience" (Sheppard, 2001).

With relatively rich visual elements (e.g., "visitors") added in, the three photomontages were expected to be interesting to visualisation audiences. However, as particularly noted by Sheppard (2001), being interesting does not mean that the visualisation should entertain the audience by adding in irrelevant visual elements. It is also mentioned by Sheppard (2001) that the photomontage techniques today were purposely used in many circumstances to entertain or "dazzle" the audience, instead of to interest the audience. In the example of the three photomontages produced, the visual elements placed in them were all necessary supplementary objects for communicating the proposed improvement – the objective of the visualisation. For example, some "tourists" were added in to provide the photomontage with a typical setting (representing the typical tourist volume on-site), while some other "visitors" who were in the process of some specific activities were placed in to communicate the function of the proposed improvements (such as the information provision function of the proposed signage in Figure 4-5 and the shade-providing function of the proposed trees in Figure 4-6). Besides these necessary supplemental visual elements, no extra irrelevant elements should be added to the visualisations. Otherwise, the visualisations could be suspected of over-entertaining to the audience. This means that there is an upper limit to the interest in the visualisation works produced by the photomontage tool. Conversely, the panoramic video simulation tool provides new possibilities for producing more "interesting" visualisation works. This will be explained in detail in Section 4.3.1.3.d.

e) Legitimacy

As explained in Section 3.5, "legitimacy" refers to the principle that "the visualisation should be defensible through making the simulation process and assumptions transparent to the viewer, and by clearly describing the expected level of accuracy and uncertainty" (Sheppard, 2001).

As previously explained, with sophisticated skills, a visualisation producer could produce highly realistic works by using the photomontage tool. However, this actually leaves considerable room for skilled producers to manipulate the visualisation result. The simulation process and assumptions can be made less transparent to the audience purposely. This means that a visualisation producer can intentionally manipulate the visual elements, the light, the atmosphere and so on without leaving any trace and still keep the visualisation highly realistic. As a result, it would be very difficult for viewers to distinguish the actual from the assumed, and the subjects from the "supplements". However, since the ultimate purpose of this evaluation is to determine the effectiveness of the visualisation tools, the producer's intention and professional ethics are not within the scope of this study. So, generally, the tools are actually neutral in legitimacy, and the only difference between the tools' legitimacies is the level of effort required for manipulating the visualisation results.

4.3.1.2 Video simulations

The three visualisation works produced by using a video simulation tool are shown in Figures 4-8, 4-9 and 4-10 (the methods of producing these video simulations are explained in Section 3.4). Only framed images from the composited video sequence were presented. The original video simulations can be viewed through the links attached.

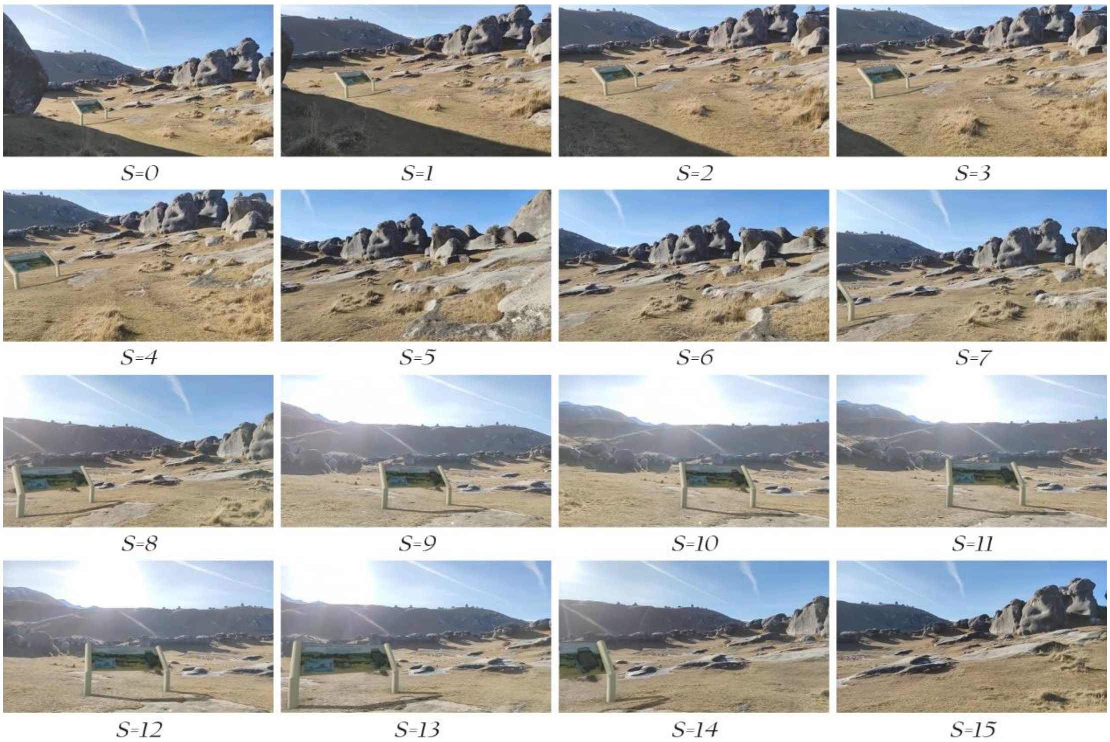

Figure 4-8 Video simulation of the proposed signage

(Click this link to watch the video: https://youtu.be/z_Evp9kPmoo)

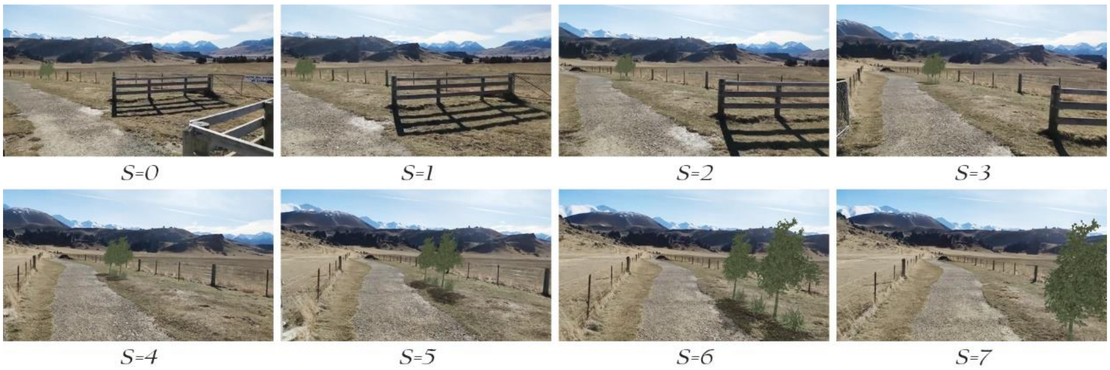

Figure 4-9 Video simulation of the proposed trees

(Click this link to watch the video: https://youtu.be/j08tPAJRuJs)

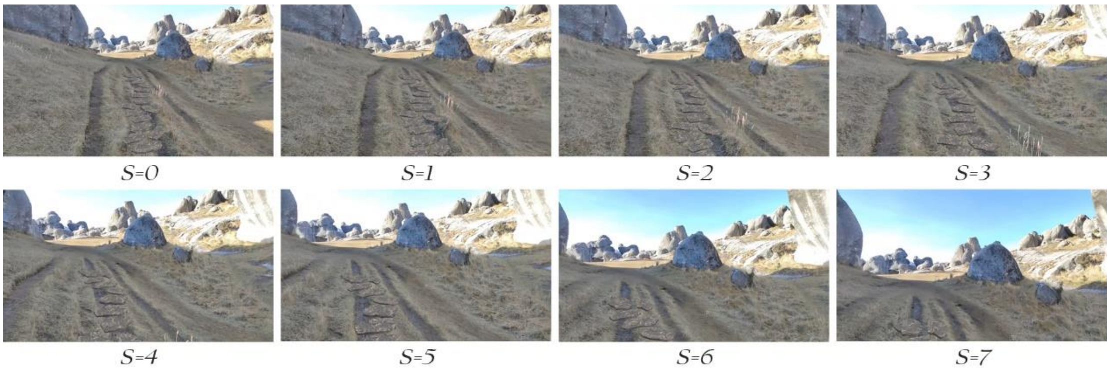

Figure 4-10 Video simulation of the proposed flagstone paving

(Click this link to watch the video: https://youtu.be/lCNjq8gRJs0)

a) Accuracy

While a higher accuracy can be expected by using the video simulation tool, the accuracy of the produced video simulations varies according to the elements placed in.

From the perspective of accuracy, a major advantage of the video simulation tool is that the elements placed in (signage, trees and flagstone pavement) are all 3D models, rather than 2D images (like the image materials placed in by using photomontage technique). Due to the use of 3D models, a perfect perspective accuracy is achieved. Different from the issues mentioned in Section 4.3.1.1.a explaining that the perspective accuracy in photomontage primarily relies on producers' technical sophistication, a producer without knowledge of spatial perspective can produce perspectively sound video simulations as well. Therefore, higher accuracy can be expected with the video simulation tool.

However, the accuracy achieved by the video simulations actually produced varies. Among the three visualised improvements, the simulation of the proposed signage has the highest accuracy while a lower accuracy was achieved with the proposed trees and flagstone pavement, for different reasons. The main reason for the difference is that placing dynamic and large-scale landscape elements is problematic in video simulations. It is noticeable that in the video simulation of the proposed trees, the trees placed in stand absolutely motionless in the wind, while other plants on site are relatively dynamic. This makes the trees look unnatural and unrealistic. In a different way, in the video simulation of the flagstone paving, the pavement does not sit still and stable on the ground, but instead, keeps "vibrating" slightly with a small amplitude. The main reason is that the video simulation tool works by recognising the characterised pixel (and 3D structure) and lets the added 3D elements track the motion of these characterised pixels. When a small-scale element was added in (such as the signage and trees in the first two visual simulations), it will track the motion of some characterised pixels that are close to each other. However, when a large-scale element was added in (such as the flagstone paving), the distance between the recognised characterised pixels would be relatively large. As a result, the distance represented between the different characterised pixels is highly likely to change frequently; however, since the 3D elements added are stable in motion, the distance between the tracking point will not change. The difference between the changing represented pixel distance of the setting and stable pixel distance of added elements makes the added element "vibrate" all the time. In summary, the accuracy of video simulations is relatively high when communicating small scale, stable visual elements, but relatively low when visualising large scale, dynamic elements.

b) Representativeness

The representativeness of three video simulations is higher than for photomontage. Photomontage represents a landscape element from a single, solid perspective. Therefore, it is relatively more difficult for the viewer to work out how the element could look from other perspectives. Video simulations, on the other hand, offer views from a constantly changing perspective. Therefore, a more holistic understanding can be achieved by viewers (such as how the signage looks, both from nearby or from a distance). Also, compared with a photomontage, a video simulation does not only represent a moment in time. Instead, the status of the visualised elements within a certain period of time is represented. In summary, the representativeness of the video simulation tool is relatively high in representing a wider range of view perspectives and more continuous time sequence.

c) Visual clarity

As explained above, a wider range of view perspectives and more continuous time sequence can be represented by video simulation. Therefore, more details of the visual elements can be achieved by viewers in the process of watching the videos.

d) Interest

Unlike photomontages, video simulations are very difficult to add dynamic visual elements (such as visitors) into. The only added elements in the three produced video simulations is the proposed landscape element itself. As a result, the video may be less interesting than the photomontage. In addition, a video may require a longer period of time from viewers. If the length of the video is not well controlled (such as the video simulation on the proposed signage), the visualisation may lose the viewers' attention. Therefore, an overall lower interest may be achieved by the video simulation tool.

e) Legitimacy

Although the visualisation tools are neutral in legitimacy, a higher level of effort is required to manipulate visualisation results (i.e., lower the visualisation legitimacy intentionally). As mentioned in Section 4.3.1.1.e, it is relatively easy to manipulate the visual elements – the light and the atmosphere and so on – in a photomontage. However, it is very difficult to do so in a video simulation.

4.3.1.3 Panoramic video simulation

The three visualisation works produced by using panoramic video simulation tool are shown in Figures 4-11, 4-12 and 4-13. (The methods of producing these panoramic video simulations are explained in Section 3.4). Only framed images from the composited video sequence are presented. The original panoramic video simulations can be viewed through the links attached.

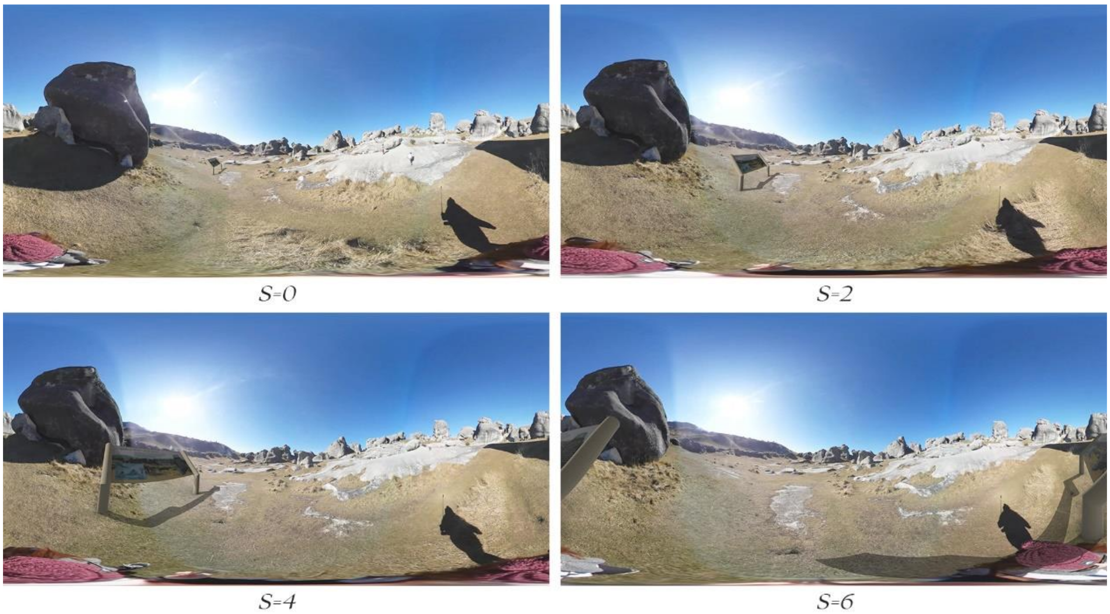

Figure 4-11 Panoramic video simulation of the proposed signage
(Click this link to watch the video: https://youtu.be/mmzPDaAPlgY)

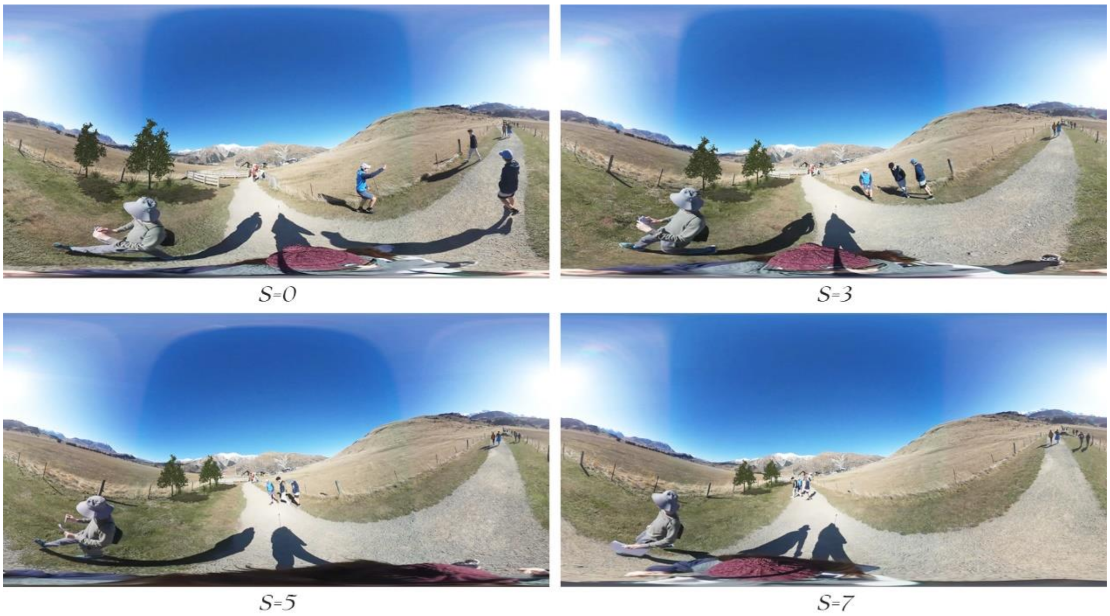

Figure 4-12 Panoramic video simulation of the proposed trees
(Click this link to watch the video: https://youtu.be/0eZ9R9H4yrE)

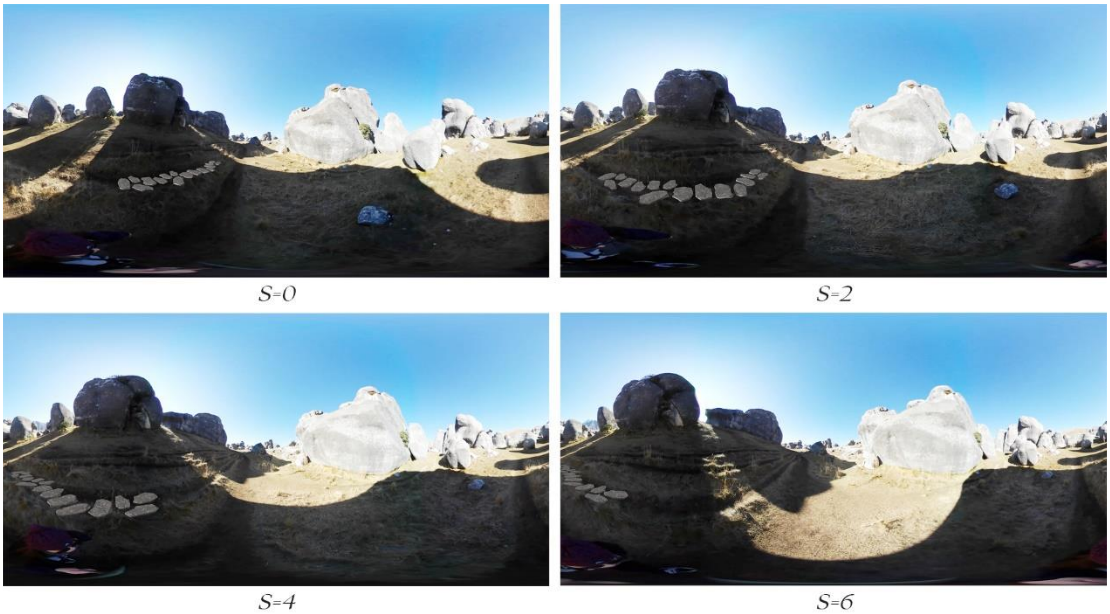

Figure 4-13 Panoramic video simulation of the proposed flagstone paving
(Click this link to watch the video: https://youtu.be/JsZFWV_qVFE)

a) Accuracy

Since the ways in which video simulation and panoramic video simulation work are similar, issues such as the trees standing still and the "vibrating" pavement were also observed in the panoramic video simulations of the trees and flagstone paving. Therefore, like the video simulation, the accuracy of panoramic video simulation is relatively high when communicating small scale, stable visual elements, but relatively low when visualising large scale, dynamic element.

b) Representativeness

Compared with the works produced by the other two visualisation tools tested, the works produced by the panoramic video simulation tool have the highest representativeness. When viewing panoramic video simulations, the viewers can choose their own viewing perspective. Compared with the other two tools, panoramic video simulations provide audiences with unlimited viewing perspectives for audiences to explore,

c) Visual clarity

As explained above, an unlimited range of view perspectives can be represented by a panoramic video simulation. Therefore, more details of the visual elements can be seen by viewers in the process of watching the videos. For example, in the panoramic simulation of the proposed signage, viewers can explore how the signage looks like from behind from the 6th second to the 9th second. However, these details cannot be represented on the video simulations and photomontages along with the front view of the signage.

d) Interest

The visualisation works produced by using the panoramic video simulation tool can be expected to be more interesting to the audience since the viewers can interact with the video and freely choose the viewing angle.

e) Legitimacy

In the same way as for the video simulation tool, the panoramic video simulation tool does not provide much room for manipulating the visualisation result. Visual elements, light, and atmosphere and so on would be very difficult to adjust when producing panoramic video simulations. However, as explained in Section 4.3.1.1.e, the tool is neutral in legitimacy.

4.3.2 Efficiency

The efficiency of using the three selected tools is evaluated based on the workflow information record in the production process. The recorded information is shown in Table 4-2.

Table 4-2 Workflow information of three visualisation tools

		Photomontage	Video	360° Video
Software	Required software	Photoshop; (SketchUp)	After Effects (with E3D plug-in); SketchUp	After Effects (with E3D plug-in); SketchUp
	Software prices	$358.66/yr (+ $299/yr)	$358.66/yr + $299/yr	$358.66/yr + $299/yr
Data	Required data	Photos of the site; Image of the proposed elements	Video footage of the site; 3D model of the proposed elements	Panoramic video footage of the site; 3D model of the proposed elements
	Data format	JPG/PNG	MP4; OBJ	MP4; OBJ
	Data exchange	Easy	Easy	Easy
Time needed for learning		0-15min	15min	15min
Time needed for producing visualisation	Time needed for collecting data	30min	30min	30min
	Time needed for producing	40min	60min	60min
Time needed for rendering		30min	60min	60min

4.3.2.1 Software

As for the cost of the required software, the three techniques were the same, as shown in Table 4-2. However, considering that SketchUp and Adobe Photoshop were probably the most widely used software today, most landscape architecture studios may already have the license to this software. Therefore, there may be no extra cost for most landscape architects to use the photomontage technique. On the contrary, Adobe After Effects is not a “conventional” software used by landscape architects. Thus, extra costs were probably required to use this software. Nevertheless, the software required for producing video simulation and panoramic video simulation is the same. This means that purchasing the Adobe After Effects could support the production of these two types of visualisations.

4.3.2.2 Data

There is no obvious difference between the data requirements of the three visualisation techniques. Since the visualisation strategy adopted by this research is to combine the captured actual landscape with the modelled (or photographed) changed landscape elements, there are generally two types of required data. For the "unchanged" part of the landscape, the data (actual landscape) were captured by using filming devices, such as cameras (for photomontage), camcorders (for video simulation), and 360 cameras (for panoramic video simulation). If there is no specific requirement on the filming quality, cameras and camcorders can even be replaced by portable devices such as mobile phones.

The proposed (or "changed") part of the landscape, on the other hand, were normally in the 3D model or image formats. As for the photomontage, both images and 3D models are applicable. However, for the video simulation and panoramic video simulation, only 3D models are applicable. The data required for representing the proposed changes in a landscape (both images and 3D models) can be downloaded from online image or 3D model sharing platform, as well as made by using graphics editing software or 3D modelling software. All these types of data are common for current landscape architectural workflows and the data can be conveniently exchanged between different computer programmes.

4.3.2.3 Time needed for learning

There are some short video tutorials about these three visualisation techniques online for beginners, which are accessible for all. These video tutorials are mostly around 15 minutes to learn. Besides, as most landscape architects may quite familiar with Photoshop software, actually, no extra time was needed for learning in most cases. Therefore, the time recorded in Table 4-2 is 0-15 minutes for learning photomontage.

4.3.2.4 Time needed for producing a visualisation

Since every visualisation technique was used to produce three visualisations. The time indicated in Table 4-2 is the average value of time needed for producing each visualisation. The producing time includes the time needed for data collecting and the time for visualisation editing. The time spent on data collecting were similar for three visualisation techniques, at around 30 minutes. The time spent on editing is generally longer, and the time spent for photomontage was different from the time for video simulation and panoramic video simulation, at around 40 minutes and 60 minutes respectively

4.3.2.5 Time needed for rendering

Similar to the producing time explained in the previous section, the rendering time indicated by Table 4-2 is also the average value of three visualisations. The time spent for photomontage rendering (i.e., adjusting light, contrast, etc.) is approximately 30 minutes. However, it takes a longer time to adjust parameters, such as lighting and shadow, for the video simulation and panoramic video simulation.

In addition, the rendering time indicated by Table 4-2 has also taken into account the time a computer spent on processing the data and exporting the final visualisation. For photomontage, the time spent on exporting is negligible. However, approximately 10 minutes, significantly longer time, were spent to export video simulation and panoramic video simulation. The exporting time is closely related to the length of the final video. The length of the video simulations and panoramic video simulations produced by this study is about 15 seconds. The longer time was expected to be spent if a longer video is produced.

Chapter 5
Discussion

5.1 A new producing strategy in landscape visualisation

A trend of landscape visualisation proposed by Bishop & Lange (2005b) – place the modelled and rendered changed part of the landscape into captured (photographed or filmed) unchanged landscape settings, rather than modelling the whole landscape, is highlighted at the end of the literature review Chapter. However, there is little research investigating such production strategy. Therefore, the first research question raised by this study is: can effective visualisation be achieved through combining the designed elements with the captured unchanged parts of a landscape?

Firstly, the answer is yes. By using software such as Adobe After Effects, computer-generated 3D landscape elements have been placed into the video footage and 360-degree video footage filmed on site. Kura Tāwhiti Castle Hill, as the background of this research, its undulating landforms and large numbers of naturally shaped limestones make up its unique landscape. A typical strategy for visualising such landscape is modelling the landform by using GIS-based software. DEM data is often required by this strategy to create accurate landform model (Lange, 2001). As for the objects on the ground, such as rocks and plants, LiDAR data were needed to create corresponding models. However, there is currently no DEM and LiDAR data for Kura Tāwhiti. Therefore, it is not applicable to visualising the landscape by using the conventional GIS-based strategy. It is also unrealistic to manually model those differently sized and shaped stones. However, by adopting the new capture-combine strategy, the researcher produced video simulations and panoramic video simulations for the landscape without using DEM and LiDAR data. Thus, this new visualisation strategy is appliable in producing such visualisations. Furthermore, the new visualisation strategy has clear advantages over the conventional strategy.

5.2 Application scope of the three selected visualisation tools

By considering the effectiveness and efficiency of the selected visualisation tools simultaneously, this study suggests the application scopes of the tools.

Photomontage, overall, is a highly efficient tool for communicating design ideas. Compared with the other two visualisation tools, the time required for producing a photomontage is fairly short. However, photomontage is relatively weak in its representativeness, visual clarity, interest and perspective accuracy. Considering the low time cost, photomontage is a cost-effective tool for communicating conceptual ideas, and has lower requirements for the accuracy, representativeness and visual clarity. However, a main characteristic of photomontage is that the visualisation results are relatively easy to manipulate. Although many commercial- or competition-oriented practices take advantage of this characteristic, manipulating the visualisation works to idealise their designs, it is considered unethical professional practice. Another outstanding characteristic of photomontage is that basic skills in perspective theory and practice are necessary to produce a perspectively sound visualisation.

In terms of video simulation, significantly more software knowledge and production time are required. However, the visualisations produced by this tool are better in representativeness and visual clarity. It is especially useful in communicating designed elements that require representation from various perspectives. However, there are still some technical limitations in using this tool. For example, the landscape elements that are dynamic or at a large scale are not suitable to be communicated with this tool (as explained in Section 4.3.1.2).

Finally, panoramic video simulation has a higher requirement for the time committed to producing a visualisation. However, there are also some significant advantages of using this tool. The works produced by using this tool are generally better in visual clarity (especially when communicating the landscape elements with complex structure), interest, representativeness and accuracy. Therefore, this technique is powerful when communicating complex projects or in some rigorous settings that need high accuracy and representativeness. In addition, it is useful in arousing the viewers' interests in participation. Therefore, it can also be used in settings in which active attention is required from viewers. Similar to the video simulation technique, there are also some technical limitations to use this tool. For example, the landscape elements that are dynamic or at a large scale are not suitable for communication with this tool (as explained in Section 4.3.1.3).

5.3 More targeted visualisation principles are needed

Visualisation techniques have been increasingly used in many different fields of landscape architecture and planning (Lange, 2011; Lovett et al., 2015). However, using visualisation may not necessarily lead to more efficient design communication. On the contrary, it sometimes can cause adverse effects on communication and decision-making (Lange, 2011; Sheppard, 2001; Steinitz, 2012); therefore, developing visualisation principles and evaluation systems is vital for more effective use of visualisation techniques.

The most widely recognised (and almost the only) set of visualisation principles (accuracy, representativeness, visual clarity, interest and legitimacy) were developed by Sheppard (2001). This set of principles was adapted to evaluate the visualisations produced in this study. By conducting this evaluation, one specific issue was highlighted – a single, generalised set of principles (or evaluation framework) was hard to effectively guide and assess a wide range of visualisation techniques, whose contexts, purposes and intended audience groups for communication differed significantly.

In this study, the focus is on using visualisation in support of public participation. However, the public involved in the process are usually not professionals in landscape architecture or other relevant industry (Lewis & Sheppard, 2006; Wu et al., 2010). A key principle for the visualisation, therefore, was to meet the needs of the layperson, that is, to make the visualisation clear, obvious and interesting. Therefore, the five principles (accuracy, representativeness, visual clarity, interest and legitimacy) suggested by Sheppard (2001) should not each be given equal importance in this case. On the contrary, in the case of applying for resource consent, where the intended audience group is professionals, instead of the layperson, the priority should be accuracy, rather than interest.

It is also suggested that there is a lack of principles or standards, and as a result, most landscape architects and planners are not clear which aspects should receive more attention (Sheppard, 2001). In some cases, visualisation practitioners may be challenged and criticised for their great difference in production standards (Downes & Lange, 2015). Therefore, more targeted visualisation principles are needed to guide the production and evaluation of visualisations for different purposes.

5.4 Introducing and adapting new techniques from other fields will be beneficial

By reviewing the history of the development of landscape visualisation, it becomes clear that most techniques and tools were not initially designed for the landscape architecture profession. Landscape architects and planners have always adapted techniques designed for other fields (Paar, 2006). For example, Computer-Aided Design (CAD) was initially designed for high-tech manufacturing industries such as aircraft and automobile parts manufacturing (Ervin, 2004). Another example is GIS-style software, which was initially developed for disciplines such as Science of Geography (ESRI, n.d.). However, these techniques were gradually adapted to many endeavours of landscape architecture and planning. Some software developers made follow-up developments that were specifically targeting users from landscape-relevant fields after recognising the new opportunities in the market of landscape visualisation. These techniques and tools became of high importance for visualisations in landscape-relevant fields. Rekittke (2002, p. 12) suggests that "[landscape architects] must be prepared to keep up to date with current developments in the field of digital technology and, if necessary, develop solutions tailored to its needs."

The researcher attempts to push the boundary of visualisation in the landscape field by adopting new tools and techniques that were developed for other fields. For example, the production of panoramic video benefits from the rapid development of panoramic technology in the past two years. The 360-degree camera is no longer the exclusive tool for specific experts. Its price is becoming more and more acceptable to ordinary people (the basic model was around NZ$100 in 2020). The combination of panoramic video and VR headsets can eliminate the screen boundary when viewing traditional photos or videos, which can help to minimise the difference between viewing through the VR device and viewing the real environment (Downes & Lange, 2015).

Another example is the use of Adobe After Effects (AE) software, placing 3D elements into video footage captured in the field, and presenting the visualisations in the form of a video and a panoramic video. AE is actually a commonly used technique in the field of animation, film and television (for example, adding spaceships to real scenes in science fiction movies).

It is obvious that the development of visualisation itself is not the expertise of landscape architects and planners. But in order to develop landscape visualisation techniques, landscape architects and planners should use advanced technology to break through the barriers of existing visualisation forms in the field of landscape. Ervin (2001) also suggests that the current research and development of landscape visualisation should integrate closely with computer science. Only by constantly looking for, learning from and trying possible technologies in other fields, can landscape architects and planners constantly supplement and expand their professional skills and forms of expression in landscape visualisation.

In fact, the new visualisation producing strategy in this study provides a new way for visualisation producers. This is an encouraging breakthrough, especially for the case of Kura Tāwhiti Castle Hill in this study, which is unable to be modelled by using traditional techniques due to the lack of the required data, to be able to visualise in the forms of video and panoramic video. More importantly, as mentioned in Chapter 2.3, the application of video and panoramic video visualisation in the process of public participation is likely to provide significant help for the subsequent decision-making process. For example, the use of panoramic video can increase people's interest in participating in investigation and discussion, so that more people are willing to participate in these processes and devote more effort to acquire the information about the landscape to be communicated (Dransch, 2000; Liu et al., 2016; Warren-Kretzschmar & Von Haaren, 2014). Another example is that video is more likely to let the public understand the designer/planner's intention in a shorter time than still image (Coggan, 2007). Video, therefore, may make the whole participation process more efficient and simpler for the organizers than using still image that needs to introduce repeatedly in every meeting with the different groups (Canter et al., 1988). More importantly, the attempt of this study has opened the possibility of combining visualisation with more advanced techniques to a certain extent. For example, the combination of panoramic video and VR headsets can eliminate the obstacles caused by screen boundary when using the devices such as smartphone and computer, and provide users with a more immersive and more realistic participation experience (Ervin, 2004; Miller et al., 2016; Paar, 2006). In the future of more mature technology, the combination of panoramic video and more different kinds of external devices may provide more unexpected participation possibilities, which is more likely to bring higher quality opinions that can reflect the real thoughts of the public, so as to help the decision-maker to make more effective decisions.

Chapter 6
Conclusion

With the rapid development over the past few decades, the visualisation today was not just limited to the conventional still image, such as photomontage. Techniques like video simulation and panoramic video simulation drew more and more attention of scholars as they can provide audiences with richer information about the landscapes to be communicated and more vivid and better sensory experience (Liu et al., 2016). However, these techniques were not well-applied in practices due to a range of reasons, such as insufficient visualisation quality (Buhmann et al., 2003; Ervin, 2001; Lange, 2001), lack of data sources (Buhmann et al., 2003; Lange, 2001), and time-consuming production workflow (Tress & Tress, 2003). A new trend of landscape visualisation is suggested by Bishop and Lange (2005b) – place the modelled and rendered changed part of the landscape into captured (photographed or filmed) unchanged landscape settings, rather than modelling the whole landscape. However, there is little research investigate such strategy for landscape visualisation.

Therefore, this research aimed to experiment with this visualisation strategy and discuss its applicability in a practical background of Kura Tāwhiti Castle Hill by comparing the effectiveness (i.e., the capacity of producing high-quality visualisation), efficiency (i.e., the ease of using the techniques) and application scope of applying the strategy in producing photomontages, video simulations and panoramic video simulations.

By using software such as Adobe After Effects, computer-generated 3D landscape elements have been placed into the video footage filmed on site. This implements the visualisation strategy proposed by Bishop and Lange (2005b), and thus, provide landscape architects with more possibility for landscape visualisation. Moreover, this would be especially helpful for visualising the nature-based landscapes like Kura Tāwhiti Castle Hill. Visualisation producers no longer need to model the complex natural settings (such as undulating terrain and naturally shaped rocks). Instead, just model the proposed changes. This has mitigated or avoided the most of technical difficulties (i.e., insufficient visualisation quality, lack of data sources, and time-consuming production workflow) that were facing by conventional "GIS-style" visualisation techniques.

Based on the above, this research also discussed several reflections achieved from the process of producing and evaluating visualisations. Firstly, the existing visualisation principles developed by Sheppard (2001) were developed for general purposes, which was hard to effectively guide and assess specific purposes. Take the purpose of public participation in this research as an example. Therefore, more targeted visualisation principles and evaluation frameworks would be beneficial. Secondly, since the most existing visualisation techniques were not originally invented for landscape architecture professionals, but adapted from other fields. Therefore, attempting to adopt the techniques developed for other fields to the practices of landscape visualisation would broaden the range of tools available for landscape architects and planners, and therefore, benefits the whole industry. The adoption of the use of AE software in this study is an example.

There are limitations in this study. First of all, this study focused on the visualisation of three types of landscape elements (signage, vegetation and flagstone pavement). However, the visualisation of different types of landscape elements is often very different. Therefore, further research on more types of landscape elements visualisation would be beneficial. Moreover, even for the visualisation of the same landscape element, different design proposals may also lead to very different evaluation results. For example, the flagstone pavement was used for the treatment of the muddy area in this study. However, other landscape interventions are also applied to such issues. For example, crushed gravel and other natural materials can be laid to reinforce the soil where the problem is less serious, while for places with serious soil erosion, it may be necessary to establish a special boardwalk. Therefore, further research on evaluating the visualisation works of these different materials will also be beneficial.

Secondly, the video simulations and panoramic video simulations were produced by using Adobe After Effect (AE) programme in this study. However, AE is not the only technique for producing such visualisations. It would be beneficial to try out other techniques for producing visualisations in the capture-combining strategy.

In addition, the practical background adopted by this research is Kura Tāwhiti Castle Hill, a nature-based landscape, which has richer topography, more curvilinear elements, and less complex structures than urban landscapes. In addition, data availability is often higher in the urban area. Therefore, more visualisation experiments for other types of landscape (e.g., urban area) will be beneficial.

Finally, the visualisations produced in this study is evaluated by the researcher in accordance with Sheppard's visualisation principles (2001) and Paar's investigation (2006). A more comprehensive understanding can be achieved by involving the public, the real audience of visualisations, in the evaluation. Therefore, another possibility to pursue in further research is to collect the audiences' opinion on such visualisation works.

References

Al-Kodmany, K. (1999). Using visualization techniques for enhancing public participation in planning and design: Process, implementation, and evaluation. *Landscape and Urban Planning, 45*(1), 37-45. doi:10.1016/s0169-2046(99)00024-9

Apse, M. G., Stewart, E., & Espiner, S. R. (2020). Stakeholder perspectives on the implications of increases in tourism on local users of nature-based recreation settings in the Selwyn District, New Zealand. In: Lincoln University. LEAP.

Barlow, J. (1995). *Public participation in urban development: The European experience*. London: Policy Studies Institute.

Barnett, S. C. (1991). *Castle Hill rock climbing: A case study of a recreation versus preservation conflict*. (Doctoral dissertation), Lincoln University.

Beierle, T. C., & Cayford, J. (2002). *Democracy in practice: Public participation in environmental decisions*: Resources for the Future.

Berry, R., & Higgs, G. (2012). Gauging levels of public acceptance of the use of visualisation tools in promoting public participation: A case study of wind farm planning in South Wales, UK. *Journal of Environmental Planning and Management, 55*(2), 229-251.

Bishop, I. D., & Lange, E. (2005a). *Visualization in landscape and environmental planning: Technology and applications*. London: Taylor & Francis.

Bishop, I. D., & Lange, E. (2005b). Visualization prospects. In I. D. Bishop & E. Lange (Eds.), *Visualization in landscape and environmental planning: Technology and applications*.

Bruce, V., Green, P. R., & Georgeson, M. A. (2003). *Visual perception: Physiology, psychology, & ecology*: Psychology Press.

Buchan, N., & Heritage, S. N. (2002). *Visual assessment of windfarms: Best practice*. Retrieved from Commissioned Report F01AA303A.: http://bankssolutions.co.uk/powys/wp-content/uploads/2013/05/Tab-1d-apps-Fto-G2.pdf

Buhmann, E., Jähne, M., & Eckert, M. (2003). Using 3D Information in Landscape Planning. *Trends in Landscape Modeling: Proceedings at Anhalt University of Applied Sciences, 2003*, 130.

Canter, D., Stea, D., & Krampen, M. (1988). *New directions in environmental participation*. Brookfield, VT: Ashgate Publishing Company.

Coggan, T. (2007). Highly accurate visual simulations power up community consultation process. *Planning Quarterly*, 25-27.

Conrad, E., Cassar, L. F., Christie, M., & Fazey, I. (2011). Hearing but not listening? A participatory assessment of public participation in planning. *Environment and Planning C:*

Government and Policy, 29(5), 761-782.

Cooke, B., & Kothari, U. (2001). The case for participation as tyranny. In *Participation: The new tyranny?* London: Zed Book.

Danahy, J. W. (2001). Technology for dynamic viewing and peripheral vision in landscape visualization. *Landscape and Urban Planning, 54*(1), 127-138. doi:10.1016/S0169-2046(01)00131-1

Department of Conservation. (n.d.). Kura Tāwhiti conservation area. Retrieved from https://www.doc.govt.nz/parks-and-recreation/places-to-go/canterbury/places/kura-tawhiti-conservation-area/

Deviating the Norm. (2015). 5 highlights from New Zealand's Great Alpine Highway drive. Retrieved from http://www.deviatingthenorm.com/blogarchive/2015/4/17/greatalpinehwy

Downes, M., & Lange, E. (2015). What you see is not always what you get: A qualitative, comparative analysis of ex ante visualizations with ex post photography of landscape and architectural projects. *Landscape and Urban Planning, 142*, 136-146. doi:10.1016/j.landurbplan.2014.06.002

Dransch, D. (2000). The use of different media in visualizing spatial data. *Computers & geosciences, 26*(1), 5-9. doi:10.1016/S0098-3004(99)00039-4

Environment Canterbury. (2010). *Canterbury regional landscape study review*. Retrieved from https://issuu.com/boffamiskell/docs/canterbury-regional-landscape-study

Ervin, S. M. (2001). Digital landscape modeling and visualization: A research agenda. *Landscape and Urban Planning, 54*(1-4), 49-62.

Ervin, S. M. (2004). *Landscape visualization: Progress and prospects*. Paper presented at the 24th Annual Esri International User Conference, San Diego, California. https://proceedings.esri.com/library/userconf/proc04/docs/pap1647.pdf

ESRI. (n.d.). What is GIS? Retrieved from https://www.esri.com/en-us/what-is-gis/overview

European Urban Knowledge Network. (n.d.). What is Public Participation? Retrieved from https://www.eukn.eu/policy-labs/policy-lab-for-cy-public-participation-in-the-development-process/general-introduction/what-is-public-participation/

Foley, J. D., Van, F. D., Van Dam, A., Feiner, S. K., Hughes, J. F., Angel, E., & Hughes, J. (1996). *Computer graphics: Principles and practice*: Addison-Wesley Professional.

Gill, L., Lange, E., Morgan, E., & Romano, D. (2013). An analysis of usage of different types of visualisation media within a collaborative planning workshop environment. *Environment and Planning B: Planning & Design, 40*(4), 742-754. doi:10.1068/b38049

Haeberling, C. (2002). 3D map presentation – A systematic evaluation of important graphic aspects. *Proceedings of ICA Mountain Cartography Workshop "Mount Hood"*. Retrieved from http://www.mountaincartography.org/mt_hood/pdfs/haeberling1.pdf

Hansen, C. D., & Johnson, C. R. (2011). *Visualization handbook*: Elsevier.

Hayward, J. A., & Boffa, F. D. (1972). Recreation in the Wairnakariri Basin. Retrieved from https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=2ahUKEwjRg5_C_obpAhUkwzgGHXGJAtsQFjAAegQIAxAB&url=https%3A%2F%2Fresearcharchive.lincoln.ac.nz%2Fbitstream%2Fhandle%2F10182%2F7595%2Flp_rm_03.pdf%3Fsequence%3D3&usg=AOvVaw0nMjDtcH6R7wsJUkjnSGWY

Hemmersam, P., Martin, N., Westvang, E., Aspen, J., & Morrison, A. (2015). Exploring urban data visualization and public participation in planning. *Journal of Urban Technology, 22*(4), 45-64.

Holman, N., & Rydin, Y. (2013). What can social capital tell us about planning under localism? *Local Government Studies, 39*(1), 71-88.

International Association for Public Participation. (2006). IAP2's public participation toolbox. Retrieved from https://atrium.lib.uoguelph.ca/xmlui/handle/10214/3122

Kempenaar, A., Westerink, J., Van Lierop, M., Brinkhuijsen, M., & Van den Brink, A. (2016). "Design makes you understand"—Mapping the contributions of designing to regional planning and development. *Landscape and Urban Planning, 149*, 20-30.

Keravel, S. (2010). The art of transmission: Mediating meaning in contemporary French landscape design. *Journal of Landscape Architecture, 5*(1), 60-71.

King, S., Conley, M., Latimer, B., & Ferrari, D. (1989). *Co-design: A process of design participation*: Van Nostrand Reinhold Company.

Kwartler, M. (2005). Visualization in support of public participation. In E. Lange & I. D. Bishop (Eds.), *Visualization in landscape and environmental planning: Technology and applications* (pp. 251-260). London: Taylor & Francis.

Lange, E. (2001). The limits of realism: Perceptions of virtual landscapes. *Landscape and Urban Planning, 54*(1-4), 163-182. doi:10.1016/s0169-2046(01)00134-7

Lange, E. (2011). 99 volumes later: We can visualise. Now what? *Landscape and Urban Planning, 100*(4), 403-406.

Lange, E., & Bishop, I. D. (2001). Our visual landscape: Analysis, modeling, visualization and protection. *Landscape and Urban Planning, 1*(54), 1-3.

Lange, E., & Hehl-Lange, S. (2005). Combining a participatory planning approach with a virtual landscape model for the siting of wind turbines. *Journal of Environmental Planning and Management, 48*(6), 833-852. doi:10.1080/09640560500294277

Langendorf, R. (2001). Computer-aided visualization: Possibilities for urban design, planning, and management. *Planning Support Systems: Integrating Geographic Information Systems, Models, and Visualization Tools*, 309-359.

Larsen, M. (n.d.). The Great Alpine Highway: Christchurch to Greymouth. Retrieved from https://www.aa.co.nz/travel/editorial/the-great-alpine-highway-christchurch-to-greymouth/

Lewis, J. L., & Sheppard, S. R. (2006). Culture and communication: Can landscape visualization improve forest management consultation with indigenous communities? *Landscape and Urban Planning, 77*(3), 291-313.

Lindquist, M., Lange, E., & Kang, J. (2016). From 3D landscape visualization to environmental simulation: The contribution of sound to the perception of virtual environments. *Landscape and Urban Planning, 148*, 216-231. doi:10.1016/j.landurbplan.2015.12.017

Liu, S., Zhang, T., & Li, C. (2016). Review on application of digital landscape architecture technology. *Journal of Human Settlements in West China, 31*(4), 1-7.

Lovett, A., Appleton, K., Warren-Kretzschmar, B., & Von Haaren, C. (2015). Using 3D visualization methods in landscape planning: An evaluation of options and practical issues. *Landscape and Urban Planning, 142*, 85-94. doi:10.1016/j.landurbplan.2015.02.021

Miller, D., Morrice, J., McKeen, M., Donaldson-Selby, G., Wang, C., & Munoz-Rojas, J. (2016). *Use of digital and 3D visualisation technology in planning for new development. Report for Scottish Government, 109.* Retrieved from https://www.gov.scot/publications/use-of-digital-3d-visualisation-technology-research-report/

Nakame, E., Qin, X., & Tadamura, K. (2004). Compositing of computer graphics with landscape video sequences. *edited by Bishop, I. and Lange, E.,"Visualization in landscape and environmental planning", Taylor & Francis*, 226-233.

Olsson, H. (2020). Landscape visualization. Retrieved from https://www.slu.se/en/departments/forest-resource-management/sections/forest-remote-sensing/arbetsomraden/landscape-visualization/

Orland, B., Budthimedhee, K., & Uusitalo, J. (2001). Considering virtual worlds as representations of landscape realities and as tools for landscape planning. *Landscape and Urban Planning, 54*(1-4), 139-148. doi:10.1016/s0169-2046(01)00132-3

Paar, P. (2006). Landscape visualizations: Applications and requirements of 3D visualization software for environmental planning. *Computers, Environment and Urban Systems, 30*(6), 815-839. doi:10.1016/j.compenvurbsys.2005.07.002

Pacione, M. (2019). The rhetoric and reality of public participation in planning. *Urban Development Issues, 63*(1), 5-15.

Pettit, C. J., Cartwright, W., & Berry, M. (2006). Geographical visualization: A participatory planning support tool for imagining landscape futures. *Applied GIS, 2*(3), 1-17. doi:10.2104/ag060022

Portman, M. E., Natapov, A., & Fisher-Gewirtzman, D. (2015). To go where no man has gone before: Virtual reality in architecture, landscape architecture and environmental planning. *Computers, Environment and Urban Systems, 54*, 376-384.

Rekittke, J. (2002). Drag and drop - The compatibility of existing landscape theories and new virtual landscapes. *Trends in GIS and Virtualization in Environmental Planning and Design, Proc. at Anhalt University of Applied Sciences*, 110-123.

Repton, H. (1803). *Observations on the theory and practice of landscape gardening*. London: Phaidon.

Robinson, C. (2019). Castle Hill rocks (Kura Tawhiti, New Zealand) – Visit tips + photos. Retrieved from https://www.zigzagonearth.com/castle-hill-rocks-kura-tawhiti-new-zealand/

Salter, J. D., Campbell, C., Journeay, M., & Sheppard, S. R. (2009). The digital workshop: Exploring the use of interactive and immersive visualisation tools in participatory planning. *Journal of Environmental Management, 90*(6), 2090-2101.

Schroth, O. (2010). *From information to participation: Interactive landscape visualization as a tool for collaborative planning* (Vol. 6): vdf Hochschulverlag AG.

Schroth, O., Sheppard, S. R., Lange, E., & Schmid, W. A. (2008). Transferring control to the user: Interactivity as an approach towards participatory visualization processes. *Digital Design in Landscape Architecture, 2008*, 203-213.

Selwyn District Council. (2019). Experience the Great Alpine Highway. Retrieved from https://selwyn.nz/experience-selwyn/selwyn-features/experience-the-great-alpine-highway/

Sheppard, S. R. (2001). Guidance for crystal ball gazers: Developing a code of ethics for landscape visualization. *Landscape and Urban Planning, 54*(1), 183-199. doi:10.1016/S0169-2046(01)00135-9

Steinitz, C. (2010). Landscape architecture into the 21st century–Methods for digital techniques. In Buhmann, Pietsch, & Kretzler (Eds.), *Digital Landscape Architecture* (pp. 2-26).

Steinitz, C. (2012). A framework for geodesign: Changing geography by design.

Tress, B., & Tress, G. (2003). Scenario visualisation for participatory landscape planning—A study from Denmark. *Landscape and Urban Planning, 64*(3), 161-178. doi:10.1016/s0169-2046(02)00219-0

United States Environmental Protection Agency. (n.d.). Public participation guide: Introduction to public participation. Retrieved from https://www.epa.gov/international-cooperation/public-participation-guide-introduction-public-participation

Walrond, C. (n.d.). The rocks of Castle Hill. Retrieved from https://www.nzgeo.com/stories/the-rocks-of-castle-hill/

Wanarat, K., & Nuanwan, T. (2013). Using 3D visualisation to improve public participation in sustainable planning process: Experiences through the creation of Koh Mudsum plan, Thailand. *Procedia-Social and Behavioral Sciences, 91*, 679-690.

Wang, C., Miller, D., Brown, I., Jiang, Y., & Castellazzi, M. (2016). Visualisation techniques to support public interpretation of future climate change and land-use choices: A case study from NE Scotland. *International journal of digital earth, 9*(6), 586-605.

Warren-Kretzschmar, B., & Tiedtke, S. (2005). What role does visualization play in communication with citizens? – A field study from the interactive landscape plan. In E. Buhmann, P. Paar, I. Bishop, & E. Lange (Eds.), *Trends in real-time landscape visualization and participation* (pp. 156-167). Heidelberg: Wichmann Verlag.

Warren-Kretzschmar, B., & Von Haaren, C. (2014). Communicating spatial planning decisions at the landscape and farm level with landscape visualization. *iForest-Biogeosciences and Forestry, 7*(6), 434-442.

Wouters, M., Hardie-Boys, N., & Wilson, C. (2011). Evaluating public input in National Park Management Plan reviews: Facilitators and barriers to meaningful participation in statutory processes. *Science for conservation, (308)*.

Wu, H., He, Z., & Gong, J. (2010). A virtual globe-based 3D visualization and interactive framework for public participation in urban planning processes. *Computers, Environment and Urban Systems, 34*(4), 291-298.

Appendix A

Initial Coding Categorisation of Survey Data

Question - What did you like LEAST about Kura Tāwhiti Castle Hill today?

Nothing
All fine with me (nothing)
Nothing (nothing)
There's nothing not to love (nothing)
All fine with me (nothing)
All fine with me (nothing)
All fine with me (nothing)
All fine with me (nothing)
All fine with me (nothing)
Nothing.it was awesome (nothing)
Nothing (nothing)
I am very happy with everything (nothing)
N/A (nothing)
N/A (nothing)
Nothing. (nothing)
Nothing (nothing)
Nothing (nothing)
N/a (nothing)
N/a (nothing)
N/A loved everything (nothing)
None (nothing)
Nothing (nothing)
Nothing, everything was lovely (nothing)
Nothing (nothing)
Nothing (nothing)
Nothing (nothing)
Nothing comes to mind (nothing)
Na (nothing)
Na (nothing)
N/A (nothing)
N/A (nothing)

N/a (nothing)
Was what I wanted, no complaints (nothing)
Not much really (nothing)
Nothing (nothing)
Nothing (nothing)

Too many people

Crowds. Development. Carparks. Tourists (too many people, busy car park)
Busy (too many people)
The impact of masses visiting with lack of respect for the place - scratching names into the rock faces. Someone flying a drone despite signage forbidding it. (too many people, graffiti on the rocks, flying of drones)
Tourists (too many people)
too many noisy tourists (too many people)
Lots of people (too many people)
Lots of people (too many people)
People :) (too many people)
It's busy (too many people)
Crowds (too many people)
Crowds (too many people)
Too crowded (too many people)
Too many people (too many people)
The tourists (too many people)
A little busy (too many people)
so many people (too many people)
All the people (too many people)
Too many people (too many people)
Not much, maybe that it's quite touristy as I prefer more quiet, out-of-track places (too many people)
People (too many people)
Tourists (too many people)

Busy car park

Crowds. Development. Carparks. Tourists (too many people, busy car park)
Busy car park (busy car park)
I worried it might be very busy maybe in the car park. (busy car park)
Car park. (busy car park)
No rubbish, not much car park room (busy car park)
Fullness of the carpark (busy car park)
Finding a park (busy car park)

Lack of signs

The way it is marketed / advertised as part of the tourist trail (lack of signs)
Lack of information about why this is a special place (lack of signs)
Lack of historic info signs, path signage (lack of signs)
I would have liked more information about the layout of the place and importance to Maori in past and present (lack of signs)
Not sure what the best way up was (lack of signs)
Not enough information about the history of the place (lack of signs)
The lack of signage (lack of signs)

Too steep

Always like stopping but somewhat vertically challenged (too steep)
Climb (too steep)
A bit hard for partner knees (too steep)
My fitness (too steep)
The hills (too steep)
The steep walk (too steep)

Bad weather

It rained haha (bad weather)
The heat (bad weather)
Wind (bad weather)
Windy (bad weather)
Weather (bad weather)
Wind (bad weather)

The trees are gone

The trees that were cut down next to parking lot (the trees are gone)
All the trees are gone :-(It was nice shadow in hot summer and part of this place for years... (the trees are gone)
That they've cut down the shelter belt trees (the trees are gone)
That the trees at the carpark are gone (the trees are gone)
That the tree lane has gone (the trees are gone)
The trees we were used to were cut down (the trees are gone)

Rubbish

If I see any rubbish. (rubbish)
Rubbish on the ground (rubbish)
toilet paper behind some rocks (rubbish)
Rubbish (rubbish)
Human waste (rubbish)

Graffiti on the rocks

Graffiti on the rocks, drones (graffiti on the rocks, flying of drones)
The impact of masses visiting with lack of respect for the place - scratching names into the rock faces. Someone flying a drone despite signage forbidding it. (too many people, graffiti on the rocks, flying of drones)
The graffiti on the rocks (graffiti on the rocks)
Graffiti on rocks (graffiti on the rocks)
Graffiti (graffiti on the rocks)

Flying of drones

Graffiti on the rocks, drones (graffiti on the rocks, flying of drones)
The impact of masses visiting with lack of respect for the place - scratching names into the rock faces. Someone flying a drone despite signage forbidding it. (too many people, graffiti on the rocks, flying of drones)
Some prick flying his drone despite the signage. (flying of drones)

Lack of trees

No shade (lack of trees)
No trees (lack of trees)
Lack of trees (lack of trees)

Muddy

The mud. (muddy)
Slippy dry bits of the track (muddy)

Animal waste

The dead animals (animal waste)
Possum poo (animal waste)

No running water

No running water (no running water)
No running water (no running water)

Erosion
The erosion (erosion)
Nothing too much to watch or do
Nothing too much to watch or do (nothing too much to watch or do)
Restroom facilities
Restroom facilities (restroom facilities)
Road noise
Road noise (road noise)
No drinking water
no drinking water (no drinking water)
Unsafe
Can be quire unsafe (unsafe)
Weeds
Weeds (weeds)
Bad language from people bouldering
Bad language from people bouldering (bad language from people bouldering)
Close to the road
Proximity to the road (close to the road)
No pub
No pub (no pub)
Not enough time to spend here
Not enough time to spend here (not enough time to spend here)
Bouldering
Bouldering, scenery (bouldering, scenery)
Scenery
Bouldering, scenery (bouldering, scenery)
Polished rock
Polished rock! (polished rock)
Buses
Buses. (buses)